MEMOIRS

OF THE

LITERARY

AND

PHILOSOPHICAL SOCIETY

OF

MANCHESTER.

Ser I

VOL. IV.

PART I.

MANCHESTER,

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1793

ADVERTISEMENT.

THE appearance of the prefent half volume, demands an explanation from the Society.—A defire to fulfil its engagement with the public as far as circumftances would permit—and alfo to comply with an exprefs law of great importance to its interefts, have induced the Society to offer the prefent publication as the firft part of a volume, which was promifed to be brought forward every two years.—It is the intention of the Society to publifh a fecond part early in the year 1794.—*Unavoidable delays, occafioned by the pre-occupation of the prefs, and the dilatorinefs of engravers, have protracted this firft part of the fourth volume beyond the limited term.—The Society muft again repeat, as a general declaration, that refponfibility for the truth of facts, or juftnefs of opinions, to be found in this or any future volume, refts with their refpective authors. The favourable reception by the public of the former volumes of thefe Memoirs, at the fame time that it demands the warmeft acknowledgments of the Society, will ferve powerfully to excite its future exertions.*

LAWS.

I. THAT the Ordinary Members only ſhall be inveſted with the privilege of voting and electing Members, and that the whole expenſes of the Society ſhall devolve upon them.

II. That Gentlemen reſiding at a diſtance from Mancheſter, ſhall be eligible into this Society, under the title of Honorary Members, provided no one be recommended who has not diſtinguiſhed himſelf by his literary or philoſophical publications.

III. That Gentlemen at a diſtance, who have favoured the Society with important communications, or from whom ſuch contributions may be expected, ſhall be eligible, under the title of Correſponding Members.

IV. That every Candidate for admiſſion into the Society, whether as an Ordinary, Honorary or Correſponding Member, ſhall be propoſed by at leaſt three Ordinary Members, who ſhall ſign a certificate of his being, from their knowledge of him, of his character, or his writings, a fit perſon to be admitted into it; which certificate ſhall be read at not leſs than two ſucceſſive meetings of the Society, previous to the election.

V. That no election ſhall be made, either of Ordinary, Honorary or Correſponding Members, except at the Quarterly

terly Meetings; and that notice ſhall be given to each Member, whenever a Candidate is nominated.

VI. That every election ſhall be conducted by ballot, and that the majority of votes ſhall decide; and that the preſident ſhall have the determining voice, if the number of votes be equal.

VII. That when an Ordinary Member removes to a greater diſtance than twenty miles from Mancheſter, he may be entitled to the continuance of the privileges of the Society, by paying five guineas to the treaſurer, in lieu of his annual ſubſcription.

VIII. That a Preſident, four Vice-Preſidents, two Secretaries, a Treaſurer and a Librarian, be elected annually by the majority of Members preſent, on the laſt Friday in the month of April. The election to be determined by ballot.

IX. That a Committee of Papers ſhall be appointed by ballot, at the ſame time, which ſhall conſiſt of the Preſident, Vice-Preſidents, Secretaries, Treaſurer and Librarian, together with ſix other Members of the Society; and that this Committee ſhall decide by ballot concerning the publication of any Paper which ſhall have been read before the Society; and ſhall ſelect, with the conſent of the author, detached parts of any Paper, the whole of which may not be deemed proper for publication; but that the preſence of ſeven Members of the Committee ſhall be neceſſary for ſuch diſcuſſion or deciſion.

X. That Viſitors may be introduced by any Member to the meetings of the Society, with the permiſſion of the Chairman.

XI. That every Member who ſhall favour the Society with communications, ſhall ſend them to one of the Secretaries, the Monday before the meeting of the Society.

XII. That

XII. That the Secretary to whom the Paper ſhall be delivered, ſhall, with the approbation of the Preſident, or two Vice Preſidents, have the power of ſuſpending the reading of it until it be referred to a meeting of the Committee of Papers, whoſe deciſion ſhall be final.

XIII. That all Papers judged admiſſible ſhall be read by one of the Secretaries, or by the author, in their order.

XIV. That no more than half an hour ſhall be allowed for the reading of any Paper, and if the whole cannot be read within that time, the remainder, except the Society determine otherwiſe, ſhall be deferred till the ſucceeding evening. No Paper however ſhall engage more than two evenings, without the conſent of the Society, expreſſed by ballot, if required.

XV. That every Ordinary Member who produces a Paper, ſhall therewith deliver a ſummary of its leading contents, which ſhall be read, paragraph by paragraph, after the Paper, to regulate its diſcuſſion.

XVI. That the Speakers ſhall direct to the Chair any obſervations they may make; and, if it be difficult to command immediate attention, it is deſirable that they ſhould ſtand up, when they addreſs the Preſident.

XVII. That authors be requeſted to furniſh the Society with an epitome of their Papers, which may be read at the meeting ſucceeding the reading of each Paper, and the diſcuſſion renewed.

XVIII. That each Ordinary Member ſhall pay one guinea annually, by half yearly payments, into the hands of the Treaſurer, to defray incidental expenſes, and to eſtabliſh a fund for the benefit of the Society. Each Member on his election to pay his Subſcription for the current half year, together with one guinea admiſſion fee.

XIX. That

XIX. That each of the Vice Prefidents, in rotation, undertake his office, for one month; during which term he fhall take the chair, in the abfence of the Prefident, at feven o'clock precifely: It is hoped that he will furnifh articles of intelligence; and when no paper is before the Society, it is expected that he provide a fubject for difcuffion.

XX. That no Laws fhall be enacted, refcinded or altered, but at the quarterly meetings, on the laft Fridays in the months of January, April, and October; and that notice fhall be given, at leaft fourteen days previous to thofe meetings.

XXI. That the Society fhall publifh a volume of mifcellaneous papers, at leaft every two years. And that at ftated times, the Committee fhall felect from the papers which have been read to the Society, fuch as fhall appear to be moft worthy of publication, but that no paper fhall be publifhed without the confent of the author. That every paper, voted for publication by the Committee of Papers, fhall be fent to the prefs without delay; that notice of the printing fhall be given to the author, and that he be entitled to thirty feparate copies, on paying the extraordinary expenfe attending them.

XXII. That a Library be formed for the ufe of the Members of this Society, and that the Librarian be authorized to purchafe fuch books as fhall be ordered at the quarterly meetings of the Society; but that no book fhall be taken out of the Library, without leave of the Librarian, limiting the time of keeping it to feven days.

XXIII. That the Refolution to eftablifh a Library be announced to the Honorary and Correfponding Members of the Society; and that it be intimated to them by the Secretaries, that donations of their paft and future publications will be *highly acceptable.*

XXIV. That

XXIV. That a GOLD MEDAL ſhall be given to the author of the moſt valuable experimental paper, containing ſome important diſcovery relative to the arts and manufactures of Mancheſter, which ſhall have been delivered to the Secretaries, and read at the ordinary meeting of the Society, before the laſt Friday in March 1794.

XXV. That the adjudication of this premium be referred to the Committee of Papers; that their deciſion ſhall be made by ballot, and that the medal ſhall be delivered by the Preſident to the perſon to whom it ſhall have been adjudged, or to his repreſentative, at the firſt meeting of the Society in October 1794.

XXVI. That two SILVER MEDALS ſhall be given *annually*, one to the author of the beſt Eſſay on a Literary, and another to the beſt on a Philoſophical Subject, which ſhall have been read at the Society during the courſe of the ſeaſon; to be determined by the Committee of Papers.

A

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CONTENTS.

CORRIGENDUM.

Pag. 133, for Horres r. Forres.

CONTENTS.

A Dis-

MEMOIRS

OF THE

LITERARY AND PHILOSOPHICAL SOCIETY.

REASONS *for ſuppoſing that* LAKES *have been more numerous than they are at preſent; with an Attempt to aſſign the Cauſes whereby they have been defaced. By* J. GOUGH, of KENDAL. — *Communicated by* DR. PERCIVAL.

WHEN we conſider what numbers of ſubmarine productions are found in the bowels of the earth, we are in a manner compelled to conclude, that the preſent inhabitable parts of our globe have, at ſome unknown period, emerged from the boſom of the ocean; and, if we attend to the diſorderly diſpoſition of the ſtrata, with other marks of violence which are every where to be met with, it is no leſs conſpicuous, that

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this grand revolution has been produced by fubterraneous convulfions. Why, then, are Lakes fo few in number?—is a queftion which, at the firft view, prefents itfelf to the mind. Lakes are either depreffions or chafms in the ground, where the waters of the neighbouring country are collected. And, if whole continents have been torn up, and have had their continuity every where broken, why are not cavities proper for forming fuch refervoirs more frequent?

This view of the fubject certainly offers a formidable objection to the received theory of the formation of land, which ought to be attended to. I will therefore make it the bufinefs of the prefent effay to enquire, whether it can be fairly obviated by an attention to the refources of Nature, and to that gradual progrefs from a rude to a more perfect ftate, which fhe obferves in all her works.

We know that the face of the earth is not now what it was formerly. Mountains, whofe acclivities are at prefent eafy and gentle, were once inacceffible through rocks and precipices. Large diftricts of land, which, at one period of time, were obftructed with fragments of ftones, and buried in afhes, have been gradually fertilized by the remains of decayed vegetables, and the decompofition of volcanic fubftances. Some rivers have deferted their ancient channels, whilft others have been entirely loft. All thefe great changes have been effected without violence, by the action of flight but inceffant

inceſſant cauſes: And why may not *lakes* have ſuffered injuries ſimilar to thoſe to which the other great works of creation are ſubject; and have been demoliſhed or totally deſtroyed, like rivers, rocks, or volcanos?—that analogy of conduct and deſign, which pervades the whole viſible ſyſtem of things, at leaſt authorizes the ſuppoſition.

We will therefore, *firſt*, enquire what means are in the poſſeſſion of Nature for producing ſuch a revolution; and, *then*, endeavour to diſcover, whether any proofs of ſuch alterations having taken place are ſtill extant.—This method of proceeding ſeems beſt calculated, either, to remove the objection, or to eſtabliſh it.

Vegetation is a favorite proceſs with nature: for ſhe has not only cloathed the plains and eminences with herbs and trees, but has alſo appropriated ſeveral ſpecies, and ſome whole *genera* to the water, for which element they are evidently intended by the ſingularity of their ſtructure. Every part of a lake abounds with vegetables, where its depth will permit them to grow, and this circumſtance is, for the moſt part, regulated by the variety of plants produced in it, and the climate where it is ſituated.—The ſterility of deep waters depends on the following cauſes: Every plant muſt be placed in a ſituation where the temperance of the ſurrounding water never deſcends below a point fixed by the conſtitution of the plant; otherwiſe, it loſes its vegetative powers. Succeſſive and increaſing degrees

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of heat are, alfo, requifite for its growth and flowering. Add to this, that the temperature of the bottom of a lake is very different in different parts; becaufe, as the depth of the water increafes, its heat becomes lefs variable, being always nearly equal to the annual mean of the country: but the temperature of parts where the depth is inconfiderable is nearly as inconftant as that of the air. Such plants, therefore, as demand a degree of warmth nearly equal to that of the Atmofphere in fummer, are always found in fhallow places; fuch as are of a colder conftitution fix their abode in deeper regions; but if any part of a lake be colder than the conftitution of the coldeft plant produced in it will bear, that part is neceffarily barren.—Aquatic vegetables, at certain periods, lofe their vegetative powers, in common with thofe that grow on land: But, while the latter are converted to earth, and afford additional fertility to the foil that raifed them; the former preferve their figure, and, in part, retain their texture for ages; for water poffeffes an antifeptic virtue, that prevents the decompofition of vegetable fubftances immerfed in it. When Julius Cæfar invaded Britain, the natives fortified a ford in the Thames, by driving pointed ftakes into the bed of the river, with a view of retarding the progrefs of the Roman Army. A number of thefe ftakes were preferved undecayed, undoubtedly by their fituation, in the time of Rapin the hiftorian, who wrote about the beginning of this century. To account for this

this antiſeptic virtue, nothing more is neceſſary than to recollect, that water protects all bodies, covered by it from the injuries of the air. If a vegetable be thrown into this fluid, all its mucilage and gum will be ſoon extracted; but the reſin, the woody fibre, and the cellular ſubſtance of the pith are not ſoluble in this element. Their decompoſition, therefore, muſt entirely depend on fermentation, a proceſs which cannot take place without a free expoſure to the atmoſphere, which communication is, in this caſe, precluded by the interpoſition of ſo unfavorable a *medium*. Few water plants acquire the properties of wood, unleſs the *cany* appearance of ſome graſſes deſerves the appellation; but they in general contain leſs mucilage, and more pith than others, conſequently, their texture is leſs ſuſceptible of injury from maceration. After having properly conſidered the foregoing obſervations, ſhould any one ſurvey a pond well ſtored with aquatic herbage, the following remarks can ſcarcely fail of receiving his approbation.

The cavity which is, at preſent, the receptacle of a pool, will, in proceſs of time, be occupied by a *ſtratum* of ſolid matter, which will conſiſt of the remains of its own produce gradually accumulated and preſerved by the water which is intimately mixed with them, and which protects them from decay. The ſubſtance with which it is conſtantly filling will acquire a compactneſs nearly uniform in every part, by the plants

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of each generation interweaving their fibres with the remains of their predeceffors; and by the depofitions of the water, which, falling to the bottom, will be lodged in its interftices. All foreign bodies, brought hither by accident, will in time be buried in the increafing foil, where they will remain for ages, without undergoing any changes, befides thofe, which are produced by the folvent power of water on particular fubftances. Should the water be moft fhallow at the fides, and increafe in depth as you advance to the middle, which is generally the cafe, the *margin* of the pond will be progreffively advanced, and its *furface* contracted in proportion. If any part of it be too cold to favor vegetation, that part will ftill remain a pool furrounded with a flat, fedgy border. If it be fupplied and emptied by two rivulets, the intermediate current will preferve itfelf a channel through the growing land. Laftly, the folid plain, thus produced, will, in time, be covered with a bed of vegetable earth, whofe thicknefs will determine the difference of high and low water-mark; for the matter between thofe two limits, being alternately wet and dry, will, at particular periods, be expofed to the action of the air, and will, confequently, be decompofed, and changed into mold.

This method of converting a pond into land evidently points out a procefs that would diminifh the inequalities of a difordered continent: And, if

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we leave ſpeculation to compare the theory with what has paſſed in the world, we ſhall find every reaſon to believe, that the plan ſuggeſted by reflexion has been employed by nature in performing the buſineſs in queſtion: For, it is upon this Principle alone, that we can account for the production of thoſe flat marſhes that ſupply many countries in the north of Europe with fuel. Several circumſtances concur to demonſtrate, that theſe ſwamps are indebted for their preſent appearance to the proceſs deſcribed above; and perhaps it will not be improper to mention a number of facts in this place, that ſeem well calculated to eſtabliſh the opinion. Could we remove from one of them all the peculiar ſoil whereby it is diſtinguiſhed from the ſurrounding land, the cavity left after the operation would ſoon be converted into a lake; for in every bog there is a quantity of water always ready to occupy any depreſſion that will anſwer the purpoſe of a reſervoir. And, in fact, humidity is ſo neceſſary to the preſervation of this kind of earth, that when it is expoſed to the air it loſes its diſtinguiſhing properties, and is changed into mold. There is another circumſtance in which the works of Nature correſpond accurately with the theory; for, in ſeveral marſhes, very deep ponds are ſtill to be met with. In ſome places they are open, and preſent themſelves to the ſight; but in others, they are dangerous pits, which are more or leſs concealed by a thin cruſt formed by aquatic plants, that float on the ſurface of

of the water without extending their roots to the bottom.

The matter of *Peat* is evidently of vegetable origin, as well as the treacherous covering mentioned above. The ufe to which it is commonly applied, fhews that it is fit for combuftion; and its afhes contain a quantity of fixed Alkali; which is rarely, however, pure, or free from mineral falts. If we examine its ftructure, it will be difcovered to confift principally of flexible, branched fibres, varioufly interwoven, and twifted together. Their arrangement proves, that they grew where they are lodged; and that they were not brought into their prefent fituation by any extraordinary agent, fuch as an inundation; for, had this been the cafe, inftead of a compact fubftance, we fhould have found an incoherent mafs of heterogeneous things, thrown loofely together without texture or connection. The lighteft and moft porous parts, being firft faturated with humidity, would have defcended to the bottom; whilft the more compact fubftances, being leaft capable of receiving an addition to their weight by imbibing water, would have remained in the higheft place. Thus we fhould have found the materials of a fwamp difpofed in *ftrata* according to their texture and fpecific gravity, provided they had all been depofited at the fame time in their prefent fituation; which fuppofition cannot be true, becaufe it is contradictory to Fact. The light, friable earth intermixed with thefe fibres has originated from the decompofition

decompofition of fuch leaves as commonly float on the furface of every pool, and are expofed to the air. Their remains, being precipitated along with other accidental impurities, have fubfided in form of mud, which has afterwards been covered with the vegetation of fucceeding years. Such is the internal ftructure of marfhes, where the produce of the original lake has alone been employed in their compofition.

But fince it is known, that they contain bodies, which are not natives of the water, foreign agents have certainly contributed to their formation: for, in digging for peat, feveral kinds of trees are difcovered, lying horizontally, at different diftances below the furface. They are commonly furrounded with the natural foil of the bog, and are rarely feen in contact with its bottom. From this circumftance it is evident, that the inferior part of the fibrous matter was formed before they came into the fituation in which they are found. It frequently happens that they all lie nearly in one direction, and are confined to a particular part of the marfh. Some are found; others more or lefs decayed. Some are mutilated and broken; others, nearly entire. In fine, the entraneous matter of a fwamp perfectly refembles the refufe of a river flowing through a woody country. In the north of England, it confifts principally of oak, afh, fir, feveral fpecies of willow, birch, and alder. Befides thefe, a great variety of leaves are dug up, with

B hazel

hazel nuts, the cones of birch and alder, a number of moſſes, and ſome ferns. I think we may ſafely conclude, that theſe ſubſtances have been brought by rivers, after heavy rains, into the primitive lakes; or, that they have been blown, from off their branches where they grew, into the water; that the trees have then been driven by the wind, which, in ſheltered places, can only blow in certain directions, into parts obſtructed by weeds, and have there been entangled and prevented from moving till, their weight growing ſpecifically greater than that of the fluid whereby they were ſupported, they have ſunk in ſuch a poſition, that the direction of the prevailing wind is commonly pointed out by the direction of their branches. The foregoing facts ſeem ſufficient to ſhew how well the theory is ſupported by the evidence of nature. I will, therefore quit this part of the enquiry; but, before the ſubject is diſmiſſed, will take the liberty of ſubjoining the following obſervations, which may perhaps be acceptable to the naturaliſt.

Firſt: I have been informed by perſons well acquainted with our marſhes, that the yew makes a part of the foſſil wood of the North of England; but it is ſo rarely found, that I have not hitherto been able to procure a ſpecimen of it, though conſiderable endeavours have been made to obtain one, as ſuch an acquiſition would incontrovertibly prove the tree to be a native of this Iſland, a circumſtance which has been diſputed of late. But

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ſince thoſe from whom my information was received had no intereſt in propagating a falſehood, their teſtimony may be relied on; and the yew will be found to have a very good claim to be accounted ind genous, becauſe the abundance of foſſil vegetables concealed in our marſhes proves that they were formed when the land was over-run with wood. Britain, therefore, numbered the yew amongſt her productions, before agriculture and the art of planting were known to her inhabitants.

Secondly: It is highly probable, that an obſerving perſon might eaſily determine to what *height* the hills of this iſland have been anciently covered with *wood:* for ſwamps are frequent on the ſides of mountains, forming horizontal planes that interrupt their declivities. In ſome of theſe, which are much elevated, no trees are found; but I know a ſmall one between two and three hundred yards above the level of the ſurrounding country, which abounds in *Birch*, and have been informed of another, where *Fir* is plentiful.

Thirdly: A thin bed of *peat* often covers the ſloping ſides of hills, where the ground is full of ſprings, but it differs in texture from the ſoil of *flat bogs*, as appears from the different methods obſerved in digging them: for the country people cut the latter horizontally; but, in working the former, they ſtrike their ſpades perpendicularly down; otherwiſe the parts detached by this ope-

ration would crumble to pieces; for the *stratum* consists of the roots of the *Juncus campestris*, heath, and other alpine plants connected in a very loose manner.

To return to the subject of the essay, it may be safely taken for granted, that the marshes of every country are similar to those of the north of England. Hence it follows that *Lakes* have once existed in every part of our Globe; and that they have been defaced by the same causes which have produced like effects in this part of the world. But nature is not confined to the process described above. She has other resources, which make a part of this inquiry, and still remain to be attended to.—In order to proceed with some degree of perspicuity, it will be necessary to premise the following circumstances, which must have attracted the notice of every one who has dedicated any part of his time to the examination of the phænomena observable in mountainous regions.

The compactest *strata* of the earth, when exposed to the atmosphere, are broken into pieces, as is evident from the immense heaps of stones which are found lying at the foot of every precipice, consisting of fragments that are continually detached from it by the injuries of the air, and have been accumulating for ages.

The truth of this proposition will be further confirmed by inspecting the side of a hill after the soil is taken away; for it appears to bemade up of masses of stone

ſtone of no determined ſize or figure; and the want of coherency is apt to give the obſerver an idea, that the whole eminence is conſtructed in the ſame looſe manner. But, if the ſuperficial rubbiſh be removed, the appearance of a ſolid rock will overturn the haſty concluſion. No kind of matter enters in any conſiderable proportion, into the *ſtrata* of the north of England, that is proof to the injuries of the atmoſphere. The *argillaceous ſaxa* are moſt ſuſceptible of its influence; and even the lofty ridges of *limeſtone*, that are found in various parts of this county, are, in ſome places, ſo far demoliſhed by the hand of time, as to be nearly buried in their own ruins. The knowledge of this method of decompoſing the hardeſt ſubſtances in the world, enables us to explain in a very eaſy manner the formation of the deep channels, along which the rivulets of a mountain are conveyed from its ſummit to the neighbouring vallies. For theſe rills, which in dry weather are ſo inſignificant as to glide unſeen among the aſperities of the hollows where they run, are liable to be converted by heavy rains into furious torrents that carry all before them. It is on theſe occaſions, that the looſe fragments of their ſtony bottoms are ſwept away, and driven to the lower ground, leaving a new ſurface of the rock expoſed to the atmoſphere, which in time is broken up by its action, and afterwards removed by the impetuoſity of ſucceeding floods. The frequent repetition of theſe deſtructive operations

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has, in some places, demolished the hardest *strata* to a depth scarcely to be credited. Now it is evident, that, where the same causes have been applied to the bank of a lake, they could not fail of producing the like effects as when exerted on the side of a hill. It may, therefore, be taken for granted, that the outlet of every lake has been more or less injured in the manner described above. This conclusion being admitted, the following consequences must immediately be assented to; because they depend on the simplest laws of Hydrostatics.

First: Wherever this process has taken place, the dimensions of the water contained in the reservoir always diminished as the depth of the channel increased through which the superfluous part was discharged.

Secondly: Its banks were gradually enlarged; and the inequalities of the bason began to rise above the surface, and assumed the appearance of islands.

Lastly: Wherever the situation of the discharging river would permit its bed to be worn to the level of the lowest part of the reservoir, the Lake has disappeared; and we find, at present, a valley in its room, containing very strong proofs of its own formation in the *stratum* of sand and pebbles with which its sides are covered. The particular situation of the outlet here alluded to depends on the figure of the bank where it is placed, which must

muſt not only be ſteep, but its deſcent muſt alſo be continued lower than the baſon, otherwiſe the lake cannot be totally defaced. For when a ſtream takes up a number of heavy bodies, it depoſits them again as ſoon as its velocity begins to diminiſh; the largeſt firſt, and the leſs in ſucceſſion, according to their bulks and comparative weights. Hence it appears, that the lower parts of the channel are continually riſing from the acceſſion of freſh materials; and the upper end is gradually depreſſed by the removal of the ſame, till the whole becomes a gentle declivity, down which the current will glide, no longer capable of diſturbing the impediments lying in its way: conſequently, the form and dimenſions of its bed will become permanent. Now, if the lower mouth of a lake arrive at this ſtate before it is ſufficiently worn away, a part of its reſervoir will for ever remain undrained, unleſs it happen to be deranged by violent cauſes; or to be filled up with ſand and pebbles brought from the adjacent country, by the rivers which flow into it. After theſe deſtructive operations have ceaſed of themſelves, there is reaſon to apprehend, from what has been diſcovered by Philoſophers, that the ſame proceſs would be continued with equal certainty, though not with equal effect, for the conſtituent particles of water are ſufficiently hard to abrade the ſurfaces of very compact bodies; it having been proved by experiment, that the coheſion of glaſs itſelf is not ſtrong enough to reſiſt their action.

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The consideration of this fact would induce one to imagine, that the bed of a river undergoes insensible changes from the friction of its own stream, after it ceases to be exposed to the more manifest ravages of a torrent. But a little attention to the œconomy of nature will remove the suspicion, by pointing out a simple preventive, which she uses to obviate the inconveniency. For when a pebble has been a while deposited in water, it is covered with several of the *imperfect* plants, most commonly with the *conferva rivularis*, and different species of *tremella*. These singular productions of the vegetable kingdom are enabled by some peculiarities of their constitution to bear the friction of a stream without receiving the least injury: And, to whatever circumstance this property is owing, it is plain that the substances in question, while they provide for their own security, must ensure the protection of whatever they envelop. By spreading over every part in contact with the water, they preserve one continued surface, and present themselves entire and uninterrupted to the action of the current; and by occupying the crevices arising from the inequalities of contiguous stones, they form a kind of cement, in which the lighter fragments being entangled, are prevented from being moved by every trivial force. Thus is permanence given to the course of every river by this simple provision of nature; and bounds are set to a process, which without it must have been unlimited.

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I have now enumerated the various caufes that contribute to the transformation of Lakes, by the gradual enlargement of their outlets, and have pointed out thofe circumftances, which in procefs of time unavoidably hinder future alterations of the kind. It will therefore be proper, in conformity to the plan of the effay, to confirm the truth of the theory by the following remarks, which I truft will not be found contradictory to the experience of any one, who has had an opportunity to make fimilar obfervations.

There are many vallies in the north of England, which, if we may judge from their appearance, have formerly been filled with water. The *coves* which feem fcooped out of the fides of feveral hills are perhaps the moft fingular objects of the kind. The entrance into one of thefe places always lies through a narrow pafs, between two fteep banks. A rivulet moft commonly flows through this opening, which, in fome cafes, conveys away the fuperfluous water of a bafon lying in the centre of the natural amphitheatre. If the courfe of this ftream be traced to fome part where its declivity is interrupted by a plane, the obferver may have an opportunity of difcovering what has once been its employment. For he will frequently find it flowing along a channel confiderably elevated by a broad bed of pebbles. The fragments conftituting this ridge are in all probability the remains of a

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rock, that formerly occupied the opening which is now the entrance to the cove.

Beſides theſe, there are other vallies of greater extent, and more diſtant from the ſummits of the hills, which appear to be the worn-out reſervoirs of ancient lakes. For, in them, the natural *ſtrata* of the country are buried under deep beds of ſand and pebbles. Their ſides are frequently diverſified with little eminences, which, in figure and ſtructure, very much reſemble the banks that are thrown up by currents: But their elevation above the neighbouring rivers forbids us to imagine that they were formed by them, as it is not uncommon to meet with ſmall hills of the kind many yards above the limits of the greateſt floods, but at the ſame time, it is evident that they have been raiſed by ſtreams of conſiderable force, as they conſiſt wholly of rolled ſtones, arranged in ſtrata with beds of ſand between them. The fineſt ſand is found in the loweſt and moſt ſequeſtered places of theſe hollows, in ſuch ſituations as theory aſſigns to it on the ſuppoſition that the bottom of a lake is the leaſt agitated by ſtorms, where the water is deepeſt.

In many places it is as ſmall as that thrown up by the ſea; but it differs in this reſpect—ſea-ſand is more or leſs mixed with ſhells, but this contains none, though the lime-ſtone that is often found in the neighbourhood abounds with them. From this fact it may be very properly inferred, that the matter in queſtion is of a more recent date, than the

the primitive ſtrata of the ſurrounding country; and that the tides of the ocean were not concerned in lodging it where we now find it. For though it would be folly to ſeek for ſhells in the heaps of pebbles deſcribed above, becauſe they would be unavoidably cruſhed to pieces, during the formation of theſe eminences, by the fragments of which they conſiſt being thrown forcibly together by the currents; yet, it is equally evident, that the gentler undulations of the water would tranſport ſuch light ſubſtances along with the fineſt particles of ſtone into the calmeſt parts of the reſervoir, and there leave them to ſubſide together. On this account it is highly reaſonable to ſuppoſe, that the beds of ſand here alluded to are not productions of the ſea; but that they have been depoſited by rivers, which, after running over ſtrata in a ſtate of decompoſition, diſcharged all the impurities collected in their reſpective courſes into vallies full of water at the time; and that the rubbiſh, which now covers their ſides, conſiſts of theſe impurities, diſpoſed in their preſent order and arrangement, by the currents of the primitive lakes.

Kendal, June 16, 1790.

An ARGUMENT *against the* DOCTRINE *of* MATERIALISM, *addressed to* THOMAS COOPER, *Esq.* — *By* JOHN FERRIAR, M. D.

READ NOVEMBER 12, 1790.

AN TOTI MORIMUR? NULLAQUE PARS MANET NOSTRI?

Senec. Troad. Act. 2.

WHEN you were employed, some time ago, my good friend, in subjecting the Doctrines of the Immaterialists to the terrible Ordeal of your Logic, you may remember, that in one of our conversations, I objected to the Material hypothesis those facts collected by Dr. Haller, which prove that great and extensive injuries have been many times sustained by the Brain, without detriment to the thinking faculty. You thought the objection inconclusive, and noticed it as such:* though not then aware of its full force, I was pleased to see it introduced by you; those important Cases (noticed by Dr. Haller for other purposes) being totally neglected, as far as I have observed, by every Writer on this question, but yourself.

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* Tracts, vol. 1. p. 181. Note.

It is natural to expect, that proofs which convince ourſelves ſhould alſo convince others; yet, though I conſider the medical facts as almoſt demonſtrating that the Brain is the Inſtrument only, not the Cauſe of the reaſoning Power, I entertain no hope of their converting one thorough Materialiſt. Hypotheſis is a Miſtreſs not eaſily abandoned, and equally courted by Philoſophers of both ſides.

It is ſaid of Democritus, that perceiving his figs to reliſh of honey, one day, he made a problem of the incident, and was proceeding to ſolve it, when his Attendant confeſſed that ſhe had kept the figs in a pot which had formerly contained honey. The Philoſopher was enraged, and complained that by this familiar explanation, he was deprived of a more important Cauſe of his own invention. Many writers ſeem to have inherited the ſpirit of the old Grecian, in the preſent Conteſt. They have run their Metaphyſical career without ſtopping to enquire for facts, and there has been great ſport, in the erection and demolition of the fanciful opinions which each party has brought into play;

—— ὡς ὅτε τις ψάμαθον πάϊς ἄγχι θαλάσσης,
Ὅς τ᾽ ἐπεὶ οὖν ποιήσει ἀθύρματα νηπιέησιν,
Ἂψ αὖτις συνέχευε ποσὶν καὶ χερσὶν, ἀθύρων.*

Your Philoſophy is of mature age, and defies the application; but too many of the Materialiſts have reckoned their doctrine eſtabliſhed, becauſe ſome

* Homer, Iliad. xv.

ſome abſurd theories of their Adverſaries were overthrown; they have accumulated their ſtrength againſt defenceleſs points; and have thought it a complete victory, to triumph, like Caligula, over rubbiſh and ſand.

Great danger attends every ſtep beyond direct inference, in reaſoning concerning the facts of Neurology. Many of them tend to perplex, and many ſeem to contradict each other. But on the preſent queſtion, though the facts are uncommon, they are complete; they cannot, therefore, be reckoned anomalous. And their authenticity would not be queſtioned even by a general reader, acquainted with the great names only of modern Philoſophy, though they had remained unnoticed by MORGAGNI and HALLER.*

The Materialiſts deny the neceſſity of any thing more than the viſible ſtructure of the brain, to produce the act of thinking, in conſequence of perception; but the contrary ſeems to be probable from theſe facts, which ſhew that, at different times, every part of that ſtructure has been deeply injured, or totally deſtroyed, without impeding or changing any part of the proceſs of thought. It is otherwiſe in the organs of Senſe. When the parts of the Brain which, in common language, give origin to the Nerves ſupplying thoſe organs, are injured,

* I have omitted a great number of facts, ſtrongly in my favour, becauſe the Authorities were not perfectly unexceptionable.

injured, the Senfes are, in general, proportionably affected. This feems to point out a difference in the Caufes of Thought and Senfation.*

Cafes in which confiderable parts of the fubftance of the brain have been loft, either by immediate injuries, or by fuppuration following wounds and fractures of the Skull, are more numerous, than conclufive.† Neither will you make much account of them, as they chiefly relate to the hemifpheres, and you feem‡ to make the bafis of the brain the moft effential part to perception, confequently, according to your fcheme, to the procefs of thinking. Of this I am very glad, for a reafon which fhall be given afterwards.

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* Do not call this affertion extravagant, till you read the following Story, quoted by WEPFER.

" Mirabilis eft capitis vulneratio, quam recenfet *Valle-*
" *riola* Obf. Med. l. 4. obf. 10. de milite quodam, qui ænei
" tormenti globulum excepit in tempore finiftro, eo paulo
" altius egrediente ex oppofito latere, diftracto et dilace-
" rato utrinque Cranio; qui citra apoplectica fymptomata,
" miraculo integre curatus fuit, nifi quod *furdafter et*
" *cæcus manferit.* De loc. affect. in Apopl. p. 205.

I dare not tranfcribe the ftory of the Polifh Nobleman which follows; (p. 206, 207)—the *ridiculum acri* may coalefce, but the *ridiculum vero* is a hazardous conjunction.

† V. Haller. Phyfiolog. T. 4. p. 316 et feq. and refpecting the Cerebellum, Morgagni, Epift. lii. §27. Haller T. 4. p. 350 et feq.—Diemerbroeck Anatom. p. 582. Wepfer Hift. Apoplecticor. (Ed. 1727) p. 208, 209.

‡ Tracts, vol. 1. p. 181. Note.

The late Dr. HUNTER was in poſſeſſion of a ſkull, in which the bones of the Cranium, on the right ſide, were every where corroded. He had opened the head ſoon after the deceaſe of the Patient, and found the whole of the right hemiſphere deſtroyed by ſuppuration. Yet the man retained his faculties perfectly till the inſtant of his death, which was ſudden.

Dr. HALLER mentions a caſe, in which half a pound of *Pus* was found in the ventricles of the brain, yet the faculties had been unimpaired till death.

Sir JOHN PRINGLE found an Abſceſs in the right hemiſphere of the brain, as large as an egg, in a patient "who had never been delirious, nor altogether inſenſible;* and in another, who "had "never been ſo inſenſible, as not to anſwer rea-"ſonably when ſpoke to," he diſcovered an abſceſs of the Cerebellum, as large as a ſmall pigeon's egg.†

LA PEYRONIE found *pus* lodged between the hemiſpheres, and compreſſing the Corpus Calloſum: when the matter was evacuated, the patient recovered, without detriment to his faculties.‡

VESALIUS

* Diſeaſes of the Army, p. 259.

† For a ſimilar caſe, ſee Wepfer. Hiſt. Apoplect. p. 363.

‡ Memoir de l'Academ. de Chirurg. An. 1703.

Vesalius found almoft nine pints of water, in the brain of a girl only two years old. She had retained her fenfes perfectly till death.*

Diemerbroeck, among other obfervations of the little effect produced on the mind, by wounds of the brain, mentions one which came under his own notice. A young Man received a thruft with a fword, in the inner Canthus of the eye, which paffed through the right lateral ventricle, and flanting upwards, almoft paffed through the fkull, at the upper angle of the Lambdoidal Suture: yet the Patient remained in his ufual ftate of mind, "cum fociis convenienter et bono cum judicio "quacunque de re differens," till the tenth day, when he was carried off by a fever.†

The fame Author quotes a cafe from Lindanus, of a patient, who, after receiving a wound in one

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* Morgag. de Cauf. & Sed. Morb. p. 37, § 2. Wepfer. 56.

In one cafe mentioned by Morgagni, where the patient died, a month after falling on the head, and where the faculties were retained to the laft, there was a curious affection of the brain: "Vix Dura detecta fuerat, cum "animadverfum eft, in Cerebri hemifphærio finiftro "tertiam anteriorem partem multo humiliorem effe fua "compari, multoque molliorem, neque in fummo tantum, "fed ubique penitus ne bafi quidem excepta. Scilicet "ob eam Mollitiem ita fubfederat: quæ Mollities cum "in corticali fubftantia erat, tum multo majus in medullari. Hæc enim in quandam velut *gelatinam* magna "ex parte mutata erat."

† Anatom. Lib. 3. p. 637.

of the lateral ventricles went about as uſual, for a fortnight. He then died. It ſeems that his Surgeon thruſt a probe into the ventricle daily, without exciting any ſenſation.*

A woman, under Diemerbroeck's immediate inſpection, whoſe ſkull was fractured by the fall of a large ſtone, loſt a quantity of brain equal in ſize to a man's fiſt, yet ſhe lived thirty-ſix days after the accident, without alienation of mind, though paralytic on the ſide oppoſite to the fracture. On diſſection, a conſiderable vacuity appeared on the right ſide (from which the portions of brain had been diſcharged) accompanied with ſuppuration, and extending through the lateral to the third ventricle, and to the Os ſphenoides. †

The moſt remarkable caſe of this kind is quoted by La Peyronie: A child, ſix years old, received a piſtol-ſhot in the head; a ſuppuration followed, during which he loſt a great quantity of the brain at every dreſſing. At the end of eighteen days he died, having retained his faculties to the laſt. When the head was opened, the portion of Brain remaining in the ſkull did not exceed the ſize of a ſmall egg.‡

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* In Dr. Haller's experiments on living Animals, the baſis of the brain appeared to be the ſeat of Senſibility. Phyſiolog. T. 4. p. 315.

† Anatom. p. 580, 1.

‡ Mem. de l'Academ. Ann. 1741.

Leſt this narration ſhould ſtartle you, as La Peyronie, in the eſſay referred to, had a favourite ſpot which he wiſhed to render the ſeat of the Soul, namely, the *Corpus Calloſum*, ſuffer me to guard it by a ſimilar quotation from the cautious Morgagni: "et ſi parietum lateralium ventriculorum craſſitudo vi aquæ fuerat in quinquenni illo Tulpii, non modo in trienni Hildani, aut bienni Veſalii, ſuperné, & ad latera uſque adeo extenuata, ut prima inſpectione nulla eſſe videretur, cum *inſtar alicujus craſſioris membranæ adhæreſceret undique arcuatæ diſſolutorum oſſium circumferentiæ*; nihil dubii eſt quin, &c.*

After reading theſe hiſtories, you would be greatly ſurprized to find, in Mr. Pott's treatiſe on Injuries of the Head, that death has ſo often followed ſlight effuſions and extravaſations under the *dura mater*, preceded by comatoſe ſymptoms, and frequently by total inſenſibility. The contraſt has often aſtoniſhed me, but does not alter the nature of the facts; and only ſerves to ſhew the danger of analogical reaſoning in Neurology, or perhaps, as a French wit has expreſſed

* Epiſt. Med. Anat. XII. Art. 8.—Conſult ſome preceding paſſages, where he aſcribes the apparent defect of brain in ſome fœtuſes to a waſting cauſed by the continued preſſure of effuſed water.

it, that Truth and Probability are not always of a ſide. *

On the faith of my Authors, then, I ſhall ſuppoſe it proved, that the thinking faculties have ſubſiſted after the deſtruction of any ſuperior or lateral part of the brain, and we will now conſider, if you pleaſe, how far they have ſurvived the depravation of the Cerebellum. To this purpoſe ſome examples are given by Morgagni†, but with ſuch a truly Italian prolixity, that I am content to wave them, and to mention ſome that may be brought within the bounds of ordinary attention.

Haller ſays, "non infrequentia ulcera Cerebelli "ſunt, etiam cum integritate mentis, morſque "inde lenta, duodecimo die, aut multo ſerior, "ſucceſſit." ‡ And he mentions ſeveral inſtances of Scirrhus affecting the Cerebellum, and producing death, without previouſly injuring the faculties. One caſe fell under his own inſpection. ||

In Morgagni's ſixty-ſecond epiſtle, art. 15, a particular account is given of a fatal Scirrhus of the Cerebellum, ſlow in its progreſs, not affecting the patient's ſenſes till the laſt, and then only by intervals.

* This thought, by the way, is attributed to St. Jerome. (See Gent. Mag. Dec. 1786)— *Multa incredibilia reperies, et non veriſimilia, quæ nihilominus tamen vera ſunt.*

† Epiſt. Anat. med. LII. Art. 26, 27.

‡ Element. Phyſiolog. p. 350.

|| Id. Ib.

tervals. The whole Cerebellum was found diſeaſed, though not equally.

The difference between the affection of the external and internal ſenſes in the following caſe, where the preſſure muſt have acted at leaſt equally upon the Cerebellum as on the Cerebrum, is worth remarking.*

" Vidit Clariſs. Dom. *Drelincurtius* tumorem
" ſteatomatis conſiſtentia, pugnique magnitudine,
" cerebrum et cerebellum inter, eó preciſé loci
" ubi conarium utrique ſubſternitur choroidis plexus
" alæ, ſpatio ſemeſtri a ſenſibili læſione, cæcitatem
" primó, ſurditatem ſubinde, omnium denique
" ſenſuum et functionum animalium abolitionem,
" & necem ipſam intuliſſe."†

Mr. Petit ſpeaks of a ſoldier, who received a muſquet ſhot in the head; the ball paſſed through the left ſide of the Cerebellum, and penetrated into the left lobe of the left hemiſphere of the brain. He ſurvived the accident forty-three hours, and his faculties were perfect to the laſt.—Mem. de l'Academ. 1748.

We will now paſs to the Basis of the Brain, the inmoſt ſeat of reaſon, according to general opinion,

* Dr. Tyſon mentions a caſe, in which the left hemiſphere was found ſphacelated, and the *teſtis* of that ſide greatly enlarged and ſtony. The patient had been ill for two months, and for the moſt part rational. (Phil. Tranſact. No. 228.)

† Addend. ad Wepfer. Hiſt. Apoplect. Obſ. 83.

opinion, and certainly, as far as we may conclude from Dr. Haller's experiments, poffeffing a nicer degree of fenfibility than the upper and lateral parts of the Mafs: diftinguifhed too, as whimfically in its different regions, by Anatomifts, as the celeftial Globe is divided by Aftronomers.

* Morgagni relates the cafe of a Man, who died on the fourteenth day of a paralytic affection, having retained his fenfes during the greateft part of the time. On opening the head, and taking out the brain, a fmall quantity of purulent matter was obferved in the bafis of the fkull; "qua "abfterfa, dum cerebrum tractatur, ibidem nova "confpicitur. Nimirum per Infundibulum e "ventriculis prodibat. Nam eadem finifter, "dexterque præfertim redundabat. Quippe in "hujus ftriato Corpore foramen erat, quocum "ulcus finuofum communicabat, tertiam partem "occupans fubftantiæ, quæ a dextris bafim cerebri "faciebat."†

The following ftory, from Tulpius,‡ deferves to be inferted entire. "Septuagenarius ebrius, "delapfus ex altiori loco, contraxit in Calvaria "tam

* I may refer you to Dr. Haller's Phyfiology for a collection of proofs (againft La Peyronie) that difeafes of the Corpus Callofum and Fornix do not affect the faculties. Tom. 4. P. 342.

† Epift. Anat.—Medic. v. Art. 2.

‡ Obferv. lib. 1. Cap. 13.—Vide Addend. ad Wepfer. Hift. Apoplect. p. 583.

" tam amplum vulnus, ut commodé per ejus
" hiatum educeretur quicquid inhæreret extimæ
" cerebri membranæ. Invadentibus ipfum nihil-
" ominus illic vertigine, vomitu ac ftupore, five
" a refidua crapula, five a concuffo cerebro, fed
" *poftridie rediit ad fe, expers febris et immunis omnium*
" *aliorum fymptomatum.* Verum die quarto, excreatis
" prius fputis purulentis, periit præter omnem
" fpem, ab inopinata apoplexia.

" Cujus ergo interiora capitis penitus perfcru-
" tantibus, obtulit fe primum frequens humor
" replens ventriculos cerebri: Sed mox longiffima
" rima excurrens continuata ferie, per frontem
" oculique foramen *ufque ad fellam equinam,**
" *prope offis cuneiformis medium:* quo loco ani-
" madvertimus (quod jure in omnium oculis
" fuit rariffimum) *ingens offis Cuneiformis fragmen-*
" *tum,* ita fejugatum a reliquo offe, ut manifefté
" elevaretur fupra quafcunque partes circumpofitas.
" Sed morbus attonitus, qui ipfum occidit, traxit
" originem partim ex obftructis proceffibus fpinalis
" medullæ (qui funt verum Nervorum principium)
" partim vero ex Anguftia *retis mirabilis.* Quibus
" nobliffimis partibus impeditis privatur homo, non
" modo fenfu ac motu, fed ipfa vita." This is
a tolerable ftroke at the rational organization of the
bafis,

* The *Pons Varolii* refts againft the middle of the pofterior clinoid proceffes which form one fide of the Sella Equina, and the cuneiform procefs of the Os Sphenoidis.

† Sphenoidis fcil.

basis, since the fracture of the Sphenoid bone, in that place, must have immediately given a great shock to the Pons Varolii, and the medulla oblongata; but I must bespeak your patience for the next quotation, which is at least as important. It is a Case of Dr. BRUNNER's in the APPENDIX to WEPFER. TRUTH distils slowly through TEUTONIC LATIN.

A Blacksmith, 64 years of age, a potent drinker, and industrious workman, (as Dr. BRUNNER tells us, in an eloquent periphrasis,) was struck down in a fit of Apoplexy on the 7th. of October, 1687, and expired immediately, though he had passed the morning in apparent good health. His faculties had never been impaired. The dissection you shall read in the Doctor's own words: "Serra satis cautè inciso cranio scalproque effracto, "dura mater circa frontem lacerata fuit leviter: "revulsurus ollam, satis firmiter sinui longitudinali "adherentem, observavi piam matrem aqua "limpida turgidissimam, instar hydatidis proruere, "& vix cavi, quin dum auferebam cranium, subinde "effluxerit aqua. Incisa dura matre nihil seri inter "hanc & piam matrem inveni, quippe jam "effluxerat. Sinus longitudinalis amplus, nihil "humoris aut Sanguinis continuit, sed omnis "refluxit versus sinus laterales fluidus. Ablata "dura matre serum perpetim exsudavit et effluxit "limpidum ---- uterque autem ventriculus aqua "scatebat turbida, quin omnes recessus et cerebri

"cavitates

"cavitates hac inundatæ et repletæ fuerunt. "Plexus choroidei fubmerfi albicabant, qui alias "rutilare confpiciuntur: hydatides aliquot in his "numeravi; ---------- Infundibulum aqua "plenum, & reliquæ cerebri cavitates aquarum "illuvie inundatæ fuerunt, præfertim *quartus ven-* "*triculus*, ut immiffus ftylus ad fpinam dorfi ufque "dilaberetur. --------- Carotides aquis merfæ "albicabant. Cerebellum minime flaccidum, fed "ficut reliquæ cerebri partes firmum apparuit. "*Tota bafis* cerebri & *ipfa fpinalis medulla* aquarum "illuvie inundata fuit: ftylus huic commiffus ibat "in profundum per fpinam dorfi. ----- certum "eft omnes cerebri receffus & cavitates fuiffe "repletas & diftentas aqua; ipfam quoque fpina- "lem medullam in fuo involucro hac penitus "fubmerfam obfervavimus.*

DR. BRUNNER adds, in the *Scholium*, that the man had been remarkably acute in his judgment. I obferve that fome facts of this kind had made an impreffion on WEPFER himfelf; for in his Exercitation *de loco affecto in Apoplexia*, he takes fome pains to fhew, againft Riolan, that the faculties are not always injured by confiderable collections of water in the Ventricles of the Brain.† Indeed,

E in

* Wepfer. Hift. Apoplect. p. 427.

See a hiftory equally ftriking in the Addenda to Wepfer, p. 607.

† P. 54 (Edit. 1724) and feq.

in hydrocephalous caſes, and in ſuppuration of the Brain, I have obſerved with aſtoniſhment, that the faculties were improving, as the fatal diſeaſe proceeded.

In the following caſe, related by Du Verney, though the condition of the baſis of the brain is not clearly deſcribed, yet a conſiderable injury muſt have been done to it, by the fracture of the Os Sphenoides in the direction ſpecified.

A Gentleman had his left eye cruſhed to pieces by a blow from a ſtone, and the orbit beaten in upon the brain. After the firſt ſhock, his faculties were entirely unimpaired, till his death, which happened on the ſeventh day; inſomuch that ſome of his medical attendants pronounced it impoſſible that the brain ſhould be injured; the appearances on diſſection were theſe "Le crane levé et le " cerveau ouvert, nous le trouvâmes rempli d'une " eſpece de bouillie qui n'etoit autre choſe qu'une " fonte d'une partie de la ſubſtance du cerveau " avec quantité de petites eſquilles qui avoient eté " pouſſeés juſques la, ou par la violence de coup, " ou par la ſuppuration. Toute la ſubſtance du " Cerveau etoit egalement contuſe et alterée juſqu'au " cervelet; leurs Anfractuoſites ſe trouvant ſe- " parées les unes des autres par la diſſolution et le " relachement de la pie-mere. Enfin le cerveau " etant oté, nous reconnumes que la partie Ante- " rieure de la ſelle de l'os Sphenoïde etoit toute " ecraſée."

" ecrasée."* But whatever you may think of this story, you will find the next, from La Peyronie, sufficiently particular.

A man, thirty years of age, who had been troubled with hypochondriacal symptoms for ten years, complained at times, during the last three months of his life, of heaviness and pain in his head, especially towards the occiput. Two days before his death, he was convulsed; but recovering, felt himself easier than he had been for a long time; the convulsion returned, and killed him in a quarter of an hour. His faculties were never affected. On dissection, the Ventricles were found dilated with water; " le plexus choroïde du quatrieme ventricule " n'etoit qu'un amas de glandes fort gonfleés et " dures; il y en avoit quelques unes au milieu " desquelles on trouvoit un petit noyau de sup- " puration; elles etoient colleés ensemble par leurs " vaisseaux & par leurs Membranes; la reunion de " ces glandes formoit *une tumeur dure environ de la* " *grosseur d'un œuf de poule*, qui occupoit la place du " cervelet, lequel n'etoit plus qu'une Membrane " glaireuse de l'epaisseur d'une ligne, et qui enve- " loppoit la tumeur; les peduncules etoient " extremement applatis, et n'avoient presque point " de consistance.

" Le corps etranger, soit par sa figure, soit par " sa situation, avoit pressé, et beaucoup diminuè

 " la

* Memoir. de l' Academ. Roy. l'an 1703

" la volume des teſtes, celui des cordons qui vont " des teſtes au Cervelet, et les cordons qui vont " du Cervelet à la Moëlle de l'epine, pour former " la plume à ecrire, enfin toute la portion de la " Moëlle allongée, qui ſ'etend depuis l'ane et la " Vulve juſqu' a la Moëlle de l'epine, etoit fort " applatie"———

Look at the perpendicular ſection of the Brain, engraved in Dr. MONRO's treatiſe on the Nervous Syſtem, and you will perceive, that preſſure in this direction muſt have produced a violent effect, on thoſe parts which you ſeem inclined to reckon the moſt important, at the baſis of the brain.

As to the *Pineal Gland*, it has ſo often been found ſuppurated,* or petrified,† or full of ſabulous particles, without any previous affection of the faculties, that it ſeems to be given up as unneceſſary to thinking, by general conſent; and as Mr. SHANDY himſelf abandoned it,‡ I think it may paſs for an untenable poſt.

HALLER quotes a caſe from Dr. RIDLEY, which I have not been able to verify by conſulting the original, and as you well know the danger of giving implicit faith to quoted quotations, you will expect to ſee Haller's own words: " Ulcus Cerebri " piam membranam et corticem ad medullam " globoſam

* Mem. de l'Acad. Royal. l'an. 1703.

† Manget. Theatr. Anatom. L. 4. C. 2.

‡ See Triſtram Shandy, vol. II.

" globofam ufque erofit, abfque dolore aut fenfuum
" læfione."*

Morgagni mentions an apoplectic patient, who died on the ninth day from the attack of the difeafe; who was for the moft part fenfible; and who could defcribe, towards the laft, the feat of his pain, in the hind-head, and along the fpine. On opening the head, much water was found in the ventricles; grumous blood collected, where the medulla fpinalis leaves the head, and many watery veficles on the crura of the medulla oblongata.†

I fhould have placed little dependance on the collections of Schenkius,‡ as moft of his authorities are become very obfcure, if they had not found credit in Bonnet's *Anatomia Practica.* Sheltered by fuch a name, I fhall venture to extract one or two of them.

Massa fpeaks of a Venetian Nobleman, who, though wounded in the back part of the head to the depth of three inches, preferved his faculties, and recovered completely.

Another

* Haller. Phyfiolog. T. 4. 338. Ridleii obferv. Anatom. p. 212. By the Medulla globofa, I prefume, we muft underftand the Medulla oblongata.

† Morgag. de Cauf. et Sedib. Morb. p. 14. § 20.

‡ Obfervat. de Cerebro.

Another of his patients received a wound from a halbert, which pierced to *the Os Baſilare:* * he retained his faculties, but became epileptic, in conſequence of a collection of pus being formed on the bone.

The wound of the Duke of Guiſe, mentioned by *Ambroſe Paré,* † is ſtill more extraordinary; yet *Paré's* authority is very great. The Duke, ſays he, was wounded in the head by the thruſt of a lance which entered under the right eye, near the noſe, and came out at the neck, between the ear and the vertebræ. The ſteel of the lance remained in the brain, and was extracted with great difficulty. The patient recovered completely. Paré, I think, ſpeaks of this caſe from his own knowledge.

But, to come ſtill cloſer to the point, Bonnet himſelf ſaw the ſtructure of the baſis wholly deſtroyed, in a patient who died after an illneſs of eleven days; who ſuffered no alienation of his faculties till within a very ſhort period before his death, and was then only delirious at times, and perfectly ſenſible during the intervals. The appearances were ſtriking. "Tota fere baſis cerebri," ſays Bonnet, "imprimis "cerebellum, et ea pars Spinalis medullæ quæ "primis

* There is an ambiguity in this word, as both the Os Occipitis and Os Sphenoidis have had this name applied to them, but from the expreſſion, and the intimation of internal ſuppuration, I conceive the latter to have been meant.

† Chirurg. Lib. 10.

" primis vertebris excipitur ---- SPHACELO * in-
" ventæ ſunt correptæ." †

The ſpinal marrow, where it leaves the head, has been ſeen greatly injured, in other caſes, where no change in the thinking powers had been obſerved.‡ It anſwers my purpoſe to remark, that in theſe different partial injuries, which we have followed round the brain, Reaſon has not been affected ſooner than Life, but objections lie againſt the concluſion which I wiſh to draw from the facts.

The principal objection that occurs to me, is that the medullary fibres of the brain decuſſate and intermix with each other, on the Pons Varolii, and at the beginning of the medulla oblongata. || In conſequence of this connection, it is eaſy to explain ſeveral phænomena in diſeaſes, eſpecially in palſies, which otherwiſe appear difficult; and in this way, it may be ſaid, when one part of the brain is deeply injured, or deſtroyed, the loſs of its activity is unfelt, becauſe, in a healthy ſtate, the oppoſite parts have formed a habit of interchanging impreſſions with each other. A ſimple encreaſe of activity, therefore,

* That Sphacelus may take place in the brain, is allowed by Morgagni. De Caus. et ſed. Morb. p. 50.

† Bonnet. Anatom. Practic. p. 42.

‡ Bonnet. Id. p. 352. Ephem. Nat. Curios. T. 6. Obſ. 1723. Wepfer. Hiſt. Apoplect. p. 379.

|| See Winſlow's Anat. *ſub titulo.*

therefore, in the ſound parts, may be ſuppoſed ſufficient for continuing the mental functions. But this objection is, in the firſt place, inconcluſive and hypothetical, for morbid affections may be transferred, as well as healthy ones; and this actually takes place, in thoſe paralytic caſes where the reſolution of the nerves is perceived, in the ſide oppoſite to that on which the brain is injured. And the objection cannot be offered, againſt concluſions drawn from the hiſtories of injury done to the baſis of the Brain, where both ſides of the Medullary ſubſtance, together with their connecting fibres, have been deſtroyed, without injury to the mind. It was on this account that I profeſſed myſelf glad of your affixing ſuch importance to the baſis.*

Another objection, which I have heard ſtarted in converſation, is that a ſtate of diſeaſe, in many of the Glands, is compatible, to a certain degree, with the exerciſe of their natural functions. To this I would anſwer, that I apprehend ſuch an objection to be quite inadmiſſible, becauſe it is an oppoſition of analogy to abſolute facts: And of analogy very unſafe, for the brain is not known to be a gland. Even if the analogy and the objection were admitted, I do not know where any facts can be learned, that ſhall bring the aſſertion to an equality, with the degree of organic læſion compatible with the exerciſe of intellect. Chronic inflammation of

the

* P. 5.

the Liver, which is attended with few and trifling fymptoms, (though a fatal difeafe) is the only confiderable inftance that I recollect. This only proves, in conjunction with many other facts, the little fenfibility of the liver, and confequently can be parallelled by no analogy with difeafes of the bafis of the brain.

Though many of the hiftories already noticed, afford examples of very extenfive difeafes in the head, yet the argument would prefs more ftrongly againft Materialifm, if it could be fhewed, that Men can think, with little, if any portion of the Brain in a found ftate. The following cafes come nearer to this point than any I have heard of. In the diffection of a perfon who died apoplectic, and who had been dull and heavy before his death, *Tulpius* found the brain flaccid, and the membranes covered with a fluid, which it was neceffary to take up with a fponge. The ventricles of the brain contained a great deal of water, and the fpinal marrow was fo drenched, that the operator was obliged to fponge it before he could examine into its condition.* *(a)*

F What

* Addend. ad. Wepfer. de Apoplex. p. 600.

(a) For the following very ftriking hiftory, I am indebted to the kind communication of Dr. Percival. " —— was " born with a very large head; but feemed well in health, " increafed in ftrength, and grew fat. The head foon " became fo unnaturally large, and the features were fo " much altered, as to leave no doubt concerning the nature " of

What PLATERUS ſaw, ſhall be told by himſelf: "Ipſam adeo cerebri ſubſtantiam in Anu quadam "defluxiſſe obſervavimus Monſpeſſuli, quæ *ſubitò* "apoplexia tacta expiravit: hujus calvariam cum "aperimus, cerebrum illius in Meninge craſſa hinc "inde fluctuare deprehendimus. Quod et diſſecta "apertaque dura dicta Matre, liquoris alicujus "ſpiſſioris et albi pultem referentis per faciem "univerſam defluebat, et hinc inde in pannos "diſpergebatur.*

Of all the learned in *us*, whom I have quoted, I believe you have the greateſt reſpect for BONNETUS; and it happens very luckily that the ſtrongeſt fact to my purpoſe depends on his own obſervation. In a patient who died after an illneſs of twelve years, without having any alienation of mind, Bonnet found the whole ſubſtance of the brain watery, and ſo ſoft that it would hardly bear the knife. The ſpinal

" of the diſeaſe. The child however increaſed in ſize, grew " ſtrong in his limbs, and took food. He could both hear " and ſee well, and ſo continued until he was eighteen " months old. He then died ſuddenly, without any con- " vulſive attack. On opening the Cranium, more than " *five quarts* of very limpid water were found within it; " there was *not the ſmalleſt trace of membrane or brain*, except " oppoſite the orbits and meatus auditorius, where ſome- " thing like medullâ ſtill remained." Dr. Quin on Dropſy of the Brain. Append. p. 105.

* Addend. ad Wepf. p. 615.

ſpinal marrow was equally tender, and ſhrunk to half its natural ſize.*

An obſervation of the ſame kind came under my own notice very lately. A girl died in the fourth month of an Arthritic complaint, with evident ſymptoms of an oppreſſed brain, but in perfect poſſeſſion of her intellectual powers. When the upper part of the ſkull was removed, before opening the Dura Mater, I was ſurprized at the flaccid appearance of the Brain; it did not ſeem to fill its Membranes, and it moved under the fingers with a very trifling reſiſtance, ſo as to feel almoſt like a poultice.† We found the Ventricles quite full of water, and an effuſion of blood upon the Tentorium, on the right ſide. But the principal diſeaſe ſeemed to be a total change in the conſiſtence and colour of the Brain, throughout. It would ſcarcely bear either handling or cutting, and the parts were uncommonly indiſtinct.

On reviewing the whole of this evidence, I am diſpoſed to conclude, that as no part of the Brain appears eſſentially neceſſary to the exiſtence of the intellectual faculties, and as the whole of its viſible ſtructure has been materially changed, without affecting the exerciſe of thoſe faculties, ſomething

 more

* Bonnet. Anatom. Pract. Tom. 1. p. 246.

† The Patient had not been dead more than twenty-four hours.

more than the diſcernible organization muſt be requiſite to produce the phænomena of thinking.*

Thus, my dear friend, have I played off my ſmall ſtock of quotations, againſt one point of your excellent Tracts; as Diogenes rolled about his tub, that he might not appear to be the only idle man in the City. I know that you will not miſinterpret this attempt to furniſh information, which medical writers only can ſupply, concerning a queſtion which you have treated with ſo much clearneſs and preciſion. However we may have differed in opinion, concerning this, and other ſubjects of importance, we have always agreed in preſerving good humour. And in ſuch a conteſt, it will be honour enough for me to ſay with Lucian,† (but without intending a pun) *κεκύλιςαι ὅ πίθος 'εν Κρανίῳ.*

* Tu ſemper fulges, divinæ particula auræ;
Igneus ille tuus vigor et cœleſtis origo
Deformem Leti faciem, tenebraſque ſilentes
Ridet, et æternæ ſpondet tibi ſæcula vitæ.
Jortin. Lus. Poet.

† Lucian: *πως δεῖν ἱςορίαν σύγγραφειν.*

COMMENTS

Comments *on* Sterne. *By.* John Ferriar, *M. D.*
Read, January 21, 1791.

——— vos adeste
Risus, blanditiæ, procacitates,
Lusus, nequitiæ, facetiæque,
Joci, deliciæque et illecebræ.
Buchanan.

THIS is almoſt the only ſatirical and ethical writer of note, who wants a commentator. The works of Rabelais, Butler, Pope, Swift, and many others, are over-loaded with explanations, while Sterne remains, in many places, unintelligible to the greater number of his readers. I would gladly diſcharge this debt of gratitude, to an Author who has afforded me much delight; but my leiſure hours can but produce ſome general traces, or occaſional hints, that amount only to an amuſing relaxation. Some perſon whoſe zeal is greater, and his literary repoſe complete, may work the mine I have opened, with profit and ſplendor.

Indeed, there is ſome danger in attempting to detect the ſources, from which Sterne drew his rich ſingularities. It has been faſhionable of late, to decry the analyſis of objects of admiration, and thoſe who wiſh to trace the myſteries of wit and literary

literary pleasure, are held to be profane dissectors, who mangle the carcase of learning, out of spleen and idle curiosity.* Besides, the originality of Sterne has scarcely been made a problem; on the contrary, he is considered as the inventor of a new style in our language. I cannot help thinking, however, with honest Mungo in the farce, that it imports us little to hear what we do not understand; and though far beneath the dignity of Horace or Pope,† who professed to admire nothing, I think it very unphilosophical, to let wonder conquer reason, especially in the closet.

To be too curious in the survey of beautiful performances, is to invite disgust. The colossal statues of Phidias, though polished to perfection without; bore a rude appearance to those who examined them

* It has been said, that a learned Gentleman intends to re-publish Joe Miller's Jests, with illustrations from the Greek writers. I expect impatiently the restoration of several of his Irish stories to Hierocles the Philosopher, from whose Αςεια those ridiculous blunders have wandered abroad, and having lost their original country, are most unfairly quartered upon Ireland.

† Nil admirari prope res est una, Numici,
Solaque, quæ possit facere et servare beatum.

Hor. Ep. Lib. 1. Ep. vi.

For fools admire, but men of sense approve.

Pope.

within:* but if a limb, or a feature of a work, ſhould appear to be purloined from the labours of a former artiſt, it would be right to look for his mark.

In tracing ſome of Sterne's ideas to other writers, I do not mean to treat him as a Plagiariſt; I wiſh to illuſtrate, not to degrade him. If ſome inſtances of copying be proved againſt him, they will detract nothing from his genius, and will only leſſen that impoſing appearance he ſometimes aſſumed, of erudition which he really wanted.

It is obvious to every one, who conſiders Triſtram Shandy as a general Satire, levelled chiefly againſt the abuſe of ſpeculative opinions, that Rabelais furniſhed Sterne with the general character, and even many particular ideas, of his work. From that copious fountain of learning, wit and whim, our author drew deeply. Rabelais, ſtored with erudition, poured laviſhly out, what Sterne directed and expanded with care, to enrich his pages.

* ἐκείνων γὰρ ἕκαστος τὰ ἐκτὸς, ὁ μὴν Ποσειδῶν, ἢ Ζεὺς ἐστὶ πάγκαλος, χρυσοῦ καὶ ἐλέφαντος ξυνειργασμένος, *** **** ἢν δὲ ὑποκύψας ἴδῃς τὰ ἔνδοθεν, ὄψει μοχλοὺς τινας, καὶ γόμφους, καὶ ἥλους διαμπὰξ πεπερονημένους, καὶ κορμοὺς καὶ σφῆνας, καὶ πίτταν ὑπόπηλον, καὶ τοιαύτην τινὰ πολλὴν ἀμορφίαν ὑποικουροῦσαν.

Lucian. Ονειρ: ἢ Αλεκτρ:

pages*. And to this appropriation, we owe many of his moſt pleaſing ſallies. For being bounded in his literary acquirements, his imagination had freer play, and more natural graces. He ſeized the groteſque objects of obſolete erudition, preſented by his original, with a vigour untamed by previous labour, and an ardour unabated by familiarity with literary folly. The curious Chapters on Noſes † afford the ſtrongeſt proof of this remark. About the time

* *καθάπερ ἐκ πολλῶν νἀμάτων εἰ τις κομίσας ῥεῦμα τι, εἰς τὴν ψυχὴν μετοχετεύσει.*

Dionys. Halicarn. Αρχ: Κρισ:

† Sterne would have made much of a paſſage in the Memoirs of La Porte: it reſpects the views of *Mademoiſelle* to a marriage with Louis 14th.—" Je dis " tout cela à la Reine, qui ſe mocqua de moi, me diſant: " ce n'eſt pour ſon nez, quoiqu'il ſoit bien grand."—

Mem. de la Porte, p. 275.

The following precious anecdote on this ſubject, occurs in the curious Miſcellany publiſhed under the aſſumed name of Vigneul Marville: " Les nés camus deplaiſent, et " ſont de mauvaiſe augure. Le Connètable Anne de " Montmorency étoit camus; et on l'appelloit à la Cour, " le Camus de Montmorency. Le Duc de Guiſe, fils " de celui qui fut tuè à Blois, étoit auſſi camus; et j'ai " connu un Gentilhomme qui ayant une vénération ſin- " guliére pour ces deux Maiſons de Guiſe et de Mont- " morency, ne ſe pouvoit conſoler de ce qu'il s'y étoit " trouvè deux camus, comme ſi ce defaut en diminuoit le " luſtre." Tom. 1. p. 140.

" He"

time when Sterne wrote, it was not forgotten indeed, that the phyſiognomy of the Noſe had been a kind of faſhionable ſubject among Philoſophers; but little was written, and little remains on the controverſy, and what Sterne gives us, is founded on the following paſſage of Rabelais: "Pourquoy, "dit Gargantua, eſt ce que frere Jean a ſi beau "nez? Par ce (repondit Grangouſier) qu'ainſi "Dieu l'a voulu, lequel nous fait en telle forme, "& telle fin, ſelon ſon divin arbitre, que fait un "potier ſes vaiſſeaux. Par ce (dit Ponocrates) "qu'il fut des premiers à la foire des nez. Il "print de plus beaux & des plus grands. Trut "avant (dit le moine) ſelon la vraye Philoſophié "Monaſtique, c'eſt, par ce que ma Nourrice avoit "les tetins molets, en l'allaictant, mon nez y "enfondroit comme en beurre, et la s'eſlevoit et "croiſſoit comme la paſte dedans la mets. Les "durs tetins des Nourrices font les enfans camus. "Mais gay, gay, ad formam naſi cognoſcitur ad "te levavi."*

G "Now

"He" (Mr. Shandy) "would often declare, in ſpeaking his thoughts upon the ſubject, that he did not conceive how the greateſt family in England could ſtand "it out againſt an uninterrupted ſucceſſion of ſix or "ſeven ſhort noſes."—Triſ. Shandy, vol. 3. chap. 33. This is a curious coincidence; I pretend to call it no more.—But it muſt be added, that Marville's Miſcellanies appear to have been much read, about the time when Sterne wrote.

* Liv. 1. Chap. xli.

"Now Ambrofe Paræus convinced my Father
"that the true and efficient caufe of what had
"engaged fo much the attention of the world,
"and upon which Prignitz and Scroderus had wafted
"fo much learning and fine parts—was neither this
"nor that—but that the length and goodnefs of the
"nofe, was owing fimply to the softnefs and flac-
"cidity of the nurfe's breaft—as the flatnefs and
"fhortnefs of puifne nofes was, to the firmnefs and
"elaftic repulfion of the fame organ of nutrition
"in the heal and lively—which, though happy
"for the woman, was the undoing of the child,
"inafmuch as his nofe was fo fnubbed, fo rebuffed,
"fo rebated, and fo refrigerated thereby, as never
"to arrive ad menfuram fuam legitimam;—but that
"in cafe of the flaccidity and foftnefs of the nurfe
"or mother's breaft—by finking into it, quoth
"Paræus, as into fo much butter, the nofe was
"comforted, nourifhed, &c."*

"—— the caufes of fhort and long nofes. There
"is no caufe but one, replied my uncle Toby,—
"why one man's nofe is longer than another's, but
"becaufe that God pleafes to have it fo. That is
"Grangoufier's folution, faid my Father.—'Tis
"he, continued my Uncle Toby, looking up,
"and not regarding my father's interruption, who
"makes us all, and frames and puts us together, in
"fuch

* Triftram Shandy, vol. iii. chap. 38.

" ſuch forms and proportions, and for ſuch ends, " as is agreeable to his infinite wiſdom."*

I wiſh Sterne had known enough of Taliacotius to have done him juſtice, on the ſubject of noſes. The practice of that extraordinary man, which has been obſcured by miſplaced raillery, and the imputation of follies entirely foreign to his method, deſerves to be better known.† It was both rational and ſuccefsful; and it is a conſiderable addition to his fame, that he anticipated later Phyſiologiſts in ſome ſurprizing and important facts reſpecting the re-union of living parts.—Sterne has played unaccountably with the public curioſity, on the ſubject of a very ſilly book, which he attempts to paſs off as curious, merely becauſe it is obſcure. This is the more ſurprizing, becauſe his fiction of Slawkenbergius is admirable. Mr. Shandy has the good fortune, we are told, to get *Bruſcambille's Prologue on Noſes* almoſt for nothing—that is, for three half crowns. " There are not three *Bruſcambiiles* in Chriſt- " endom —ſaid the ſtall-man, except what are " chained up in the libraries of the curious."—This is well calculated to excite the appetites of epicures in literature, which perhaps was all the Author intended; and which is ill ſupported by the work in queſtion. That no future Collector

 may

* Id. Chap. 41.

† See his Book, De Curtorum Chirurgia.

may figh for Brufcambille, I will give as much of his Prologue on Nofes as deferves the patience of a Reader. I fhall only premife, that the book confifts of a fet of profe difcourfes, printed at Cologne, in 1741, which feem to have ufhered in comedy,* farce, or puppet-fhow, according to the exigencies of the night: they refemble the Prologues of Terence, only in the freedom with which Monf. Brufcambille treats his audience.

"Je n'entreprend point de faire ici une ample "defcription des differens nez, avec les proprietez "fingulieres qui leur font annexées; j'en dirois "peut etre trop des grands nez au préjudice des "nez mediocres, des petits nez, des nez cornus, "des nez plats, & autres de toute forte d'efpece, "je me contente de dire que les grands nez ont "beaucoup d'avantage fur les petits pour les odeurs "dont ils font l'organe naturel, d'autant que par "leur capacitè plus etendue ils peuvent reçevoir "plus de vapeurs odoriférentes & que celles qui "montent de bas en haut leur peuvent moins "echapper qu'aux petits nez: en un mot, Meffieurs, "fi c'eft quelque chofe de beau, de bon, de löuable, "d'avantageux en tout genre d'avoir du nez, il le "doit

* The firft is entitled, *Premier Prelude, en forme de Galimatias, pour l'ouverture du Theatre.* Several others are faid to be *en forme de Galimatias*, but the fpecification was needlefs.

"doit être encore plus d'avoir du grand nez," &c. Jam ſatis.*

The mock quotations, explanatory of the *Promontory of Noſes*, in Slawkenbergius's tale, are merely deſigned to cover the uſe made of Rabelais's proverb; "il fut à la foire des nez." Sterne has diverted himſelf ſometimes with references to ſome parts of this author, that appear ænigmatical enough. For inſtance; "Who was Tickletoby's Mare?"† I believe many of Rabelais's readers would be puzzled to anſwer. Sterne alludes to the ſtory of poor Tappecoue,‡ who fell a ſacrifice to the reſentment of the devils of Poictiers.

At other times, Sterne indulges in all the Galimatias of the old Frenchman. ——"Bon jour! "good morrow!—ſo you have got your cloak on "betimes! but 'tis a cold morning, and you judge "the matter rightly—'tis better to be well mounted "than go o' foot—and obſtructions in the glands "are dangerous—And how goes it with thy Con-"cubine—thy wife—and thy little ones o' both ſides? "and when did you hear from the old gentleman "and lady," &c.‖

I believe

* Penſées Facetieuſes de Bruſcambille. P. 48.

† Chap. 36. vol. ii. Tr. Shandy.

‡ Rabelais. Liv. IV. Chap. XIII. That ſtrange fellow, Sir Thomas Urquhart, the Romancer of Crichton, tranſlates this word, Tickletoby.

‖ Vol. viii. Chap. 3.

I believe this brilliant paffage is founded on the Prologue to Rabelais's fourth Book. Some of Sterne's other imitations do him more credit; but in the eighth volume of Triftram he was not very nice in taking affiftance. " Gens de Bien, fays " Rabelais, " Dieu vous fauve et gard. Ou eftes " vous? je ne peux vous voir. Attendez que je " chauffe mes lunettes. Ha, ha, bien & beau f'én " va Quarefme, je vous voy. Et doncques? " Vous avez eu bonne vinee, a ce que l'on m'a dit. " ---- Vous, vos femmes, enfans, parens et familles " eftes en fantè defiree. Cela va bien, cela eft bon, " cela me plaift—" &c. Certainly this trafh muft be one of thofe paffages, efcaped, as Rabelais declares that he wrote ' en mangeant et buvant,' after he had taken a cup too much.

Perhaps it would do violence to the analogy, to fay that the exquifite dialogues, fcattered through Triftram Shandy, took any colour from thofe delivered by Rabelais.—At leaft, it would appear to be refining too far. Yet the contraft and contention of characters and profeffions fo ftriking in both romances; the ftrong ridicule thrown upon the love of hypothefis; and the art with which abfurdities in every walk of fcience are expofed, have always impreffed me with a general idea of refemblance; and have recalled Pantagruel, Panurge and Epiftemon, in many of the Shandean converfations. If there be any degree of imitation in this refpect, it is greatly to Sterne's honour. A higher polifh was never

never given to rugged materials. But there can be no doubt refpecting Sterne's obligations to another Author, once the favourite of the learned and witty, though now unaccountably neglected. I have often wondered at the pains beftowed by Sterne, in ridiculing opinions not fafhionable in his day, and have thought it fingular, that he fhould produce the portrait of his Sophift, Mr. Shandy, with all the ftains and mouldinefs of the laft century about him. For the love of fcarce and whimfical books, was no vice of the time when Triftram Shandy appeared. But I am now convinced, that all the fingularities of that character were drawn from the perufal of *Burton's Anatomy of Melancholy*; not without reference,* however, to the peculiarities of Burton's life, who is alledged to have fallen a victim to his aftrological ftudies. We are told, accordingly, that Mr. Shandy had faith in aftrology.†

The *Anatomy of Melancholy*, though written on a regular plan, is fo crouded with quotations, that the reader is apt to miftake it for a book of common-places. The opinions of a multitude of Authors are collected, under every divifion, without arrangement, and without much nicety of felection, to undergo a general fentence; for the bulk of the materials

* Even the name of Democritus junior, affected by Burton, may have led to Sterne's affumption of the title of Yorick. Burton too was a Clergyman.

† Vol. iii. Chap. 23. Vol. v. Chap. 28.

materials enforces brevity on the writer. In the courfe of a moderate folio, Burton has contrived to treat a great variety of topics, that feem very loofely connected with his fubject; and, like Bayle, when he ftarts a train of quotations, he does not fcruple to let the digreffion outrun the principal queftion. Thus, from the Doctrines of Religion, to Military Difcipline; from inland Navigation, to the Morality of Dancing Schools, every thing is difcuffed and determined. The quaintnefs of many of his divifions feems to have given Sterne the hint of his ludicrous titles to feveral Chapters;* and the rifible effect refulting from Burton's grave endeavours, to prove indifputable facts by weighty quotations, he has happily caught, and fometimes well burlefqued. This was the confequence of an opinion, prevalent in the laft age, which a late writer has attempted to re-eftablifh refpecting Hiftory; that authorities are facts.

But where the force of the fubject opens Burton's own vein of Profe, we difcover valuable fenfe and brilliant expreffion. The proof of this will appear in thofe paffages, which Sterne has borrowed from him without variation. Burton was likewife a Poet; a copy of verfes in Latin, and another in Englifh, prefixed to his book, afford no mean proofs of his

* The Tale of a Tub, and the Memoirs of Scriblerus, muft come in for a fhare of this influence.

genius.* The Anatomy of Melancholy has always been a ſource of ſurreptitious learning; Anthony a-Wood ſpeaks of it, as a compilation highly uſeful to Gentlemen who were negligent at College; and Archbiſhop Herring alledged that the wits who flouriſhed under Queen Anne and George the Firſt, were under great obligations to it.† In

* The late Mr. Warton, in his edition of Milton's Smaller Poems, has noticed the analogy between theſe Engliſh verſes, and the Allegro & Penſeroſo. Burton alternates them, thus:

When I go muſing all alone,
Thinking of divers things fore-known,
When I build Caſtles in the air,
Void of Sorrow, void of Fear,

Pleaſing myſelf with phantoms ſweet,
Methinks the time runs very fleet.
All my joys to this are folly,
Nought ſo ſweet as melancholy.

When I go walking all alone,
Recounting what I have ill done,
My thoughts on me then tyrannize,
Fear and ſorrow me ſurprize;
Whether I tarry ſtill or go
Methinks the time moves very ſlow.
All my griefs to this are jolly,
Nought ſo ſad as melancholy, &c.

There is a direct imitation of theſe verſes in Voltaire's
'Jean qui pleure, et Jean qui rit.'

† Biograph. Dict. Art. Burton (Rob.)

The ſtory of Dr. Parnell's beautiful allegory on Man, is taken from Burton, p. 64.

literature, the ſprings are commonly more copious than their derived ſtreams, and are therefore more highly honoured. But though this applies to Burton, and moſt of his imitators, it fails in reſpect of Triſtram Shandy, where, though much is directly drawn from our Author, there are many delightful windings, widely diſtant from his influence. I would therefore beware of imitating the raſhneſs of a Traveller, who ſhould fancy he had diſcovered the ſecret head of a mighty river, while, deceived by imperfect intelligence, he had only explored the ſource of an auxiliary ſtream.

The firſt four chapters of Triſtram Shandy, are founded on ſome paſſages in Burton, which I ſhall tranſcribe. Sterne's improvements I ſhall leave to your recollection.

" Filii ex ſenibus nati raro ſunt firmi tempera-
" menti, &c. Nam ſpiritus cerebri ſi tum malé
" afficiantur, tales procreant, & quales fuerint
" affectus, tales filiorum, ex triſtibus triſtes, ex
" jucundis jucundi naſcuntur [Cardan.] " If ſhe"
(the mother) " be over-dull, heavy, angry, peeviſh,
" diſcontented and melancholy, not only at the
" time of conception, but even all the while ſhe
" carries the child in her womb (ſaith Fernelius)
" her ſon will be ſo likewiſe, and worſe, as Lem-
" nius adds, &c. ----- So many ways are we
" plagued and puniſhed for our fathers defaults;*
" inſomuch

* This idea runs through Triſtram Shandy.

" infomuch that as Fernelius truly faith, it is the " greateft part of our felicity to be well-born, and " it were happy for human kind,* if only fuch " parents as are found of body and mind, fhould be " fuffered to marry. Quanto id diligentius in " procreandis liberis obfervandum."† I cannot help thinking, that the firft chapter or two of the Memoirs of Scriblerus whetted Sterne's invention, in this, as well as in other inftances of Mr. Shandy's peculiarities.

The forced introduction of the fneer at the term non-naturals,‡ ufed in medicine, leads us back to Burton, who has infifted largely and repeatedly, on the abufe of th functions fo denomin ted.

It is very fingular, that in the introduction to the Fragment on Whifkers, which contains an evident Copy, Sterne fhould take occafion to abufe Plagiarifts. " Shall we for ever make new books, " as Apothecaries make new mixtures, by pouring " only out of one veffel into another?" Ex ore

 tuo

* See Triftram Shandy, Vol. viii. Chap. 33.

† Anat. of Melanch. p. 37. Edit. 1676.

Quanto id diligentius in liberis procreandis cavendum, fayeth Cardan. Trif. Shandy, Vol. vi. Ch. 33.

‡ Tr. Sh. Vol. i. Chap. 23.—" Why the moft natural actions of a Man's life fhould be called his non-naturals, is another queftion."—See Burton, p. 39. The folution might be eafily given, if it were worth repeating.

tuo—"Shall we be deſtined to the days of eternity, "on holidays, as well as working-days, to be "ſhewing the relics of learning, as monks do the "relics of their ſaints—without working one—one "ſingle miracle with them?"—Here we muſt acquit Sterne: he has certainly done wonders, wherever he has imitated or borrowed.—

"One denier, cried the order of mercy—one "ſingle denier, in behalf of a thouſand patient "captives, whoſe eyes look towards heaven and "you for their redemption.

"—— The Lady Bauſſiere rode on.

"Pity the unhappy, ſaid a devout, venerable, "hoary-headed man, meekly holding up a box, "begirt with iron, in his wither'd hands—I beg "for the unfortunate—good, my lady, 'tis for a "priſon—for an hoſpital—'tis for an old man—a "poor man undone by ſhipwreck, by ſuretyſhip, "by fire—I call God and all his angels to witneſs— "'tis to clothe the naked—to feed the hungry— "'tis to comfort the ſick and the broken-hearted.

"—— The Lady Bauſſiere rode on.

"A decayed kinſman bowed himſelf to the ground.

"—— The Lady Bauſſiere rode on.

"He ran begging bare-headed on one ſide of her "palfrey, conjuring her by the former bonds of "friendſhip, alliance, conſanguinity, &c.—couſin, "aunt, ſiſter, mother—for virtue's ſake, for your

"own,

" own, for mine, for Chrift's fake, remember me—
" pity me.

" —— The Lady Bauffiere rode on."*

The citation of the original paffage from Burton will confirm all I have faid of his ftile.

" *A poor decay'd kinfman of his fets upon him by the*
" *way in all his jollity, and runs begging bare-headed by*
" *him, conjuring him by thofe former bonds of friendfhip,*
" *alliance, confanguinity, &c. uncle, coufin, brother,*
" *father, ---- fhew fome pity for Chrift's fake, pity a*
" *fick man, an old man, &c. he cares not, ride on:*
" *pretend ficknefs, inevitable lofs of limbs, plead furetyfhip,*
" *or fhipwreck, fires, common calamities, fhew thy wants*
" *and imperfections, ---- fwear, proteft, take God and*
" *all his angels to witnefs, quære peregrinum, thou art a*
" *counterfeit crank, a cheater, he is not touched with it,*
" *pauper ubique jacet, ride on, he takes no notice of it.*
" *Put up a fupplication to him in the name of a thoufand*
" *orphans, an hofpital, a fpittle, a prifon as he goes by,*
" *they cry out to him for aid: ride on ----- Shew*
" *him a decay'd haven, a bridge, a fchool, a fortification,*
" *&c. or fome public work; ride on. Good your worfhip,*
" *your honour, for God's fake, your Country's fake:*
" *ride on.*"†

This curious Copy is followed up, in Triftram Shandy, by a Chapter, and that a long one, written almoft

* Triftram Shandy, Vol. v. Chap. 1.

† Anat. of Melanch. p. 269.

almoſt entirely from Burton. It is the Conſolation of Mr. Shandy, on the death of Brother Bobby.

"When Agrippina was told of her ſon's death, "Tacitus informs us, that, not being able to moderate the violence of her paſſions, ſhe abruptly "broke off her work." This quotation did not come to Sterne from Tacitus. "*Mezentius would not live after his ſon - - - - And Pompey's wife cry'd out at the news of her huſband's death, Turpe mori poſt te, &c.—as Tacitus of Agrippina, not able to moderate her paſſions: So when ſhe heard her Son was ſlain, ſhe abruptly broke off her work, changed countenance and colour, tore her hair, and fell a roaring downright.*"*

"'Tis either Plato," ſays Sterne," or Plutarch, "or Seneca, or Xenophon, or Epictetus, or Theophraſtus, or Lucian—or ſome one, perhaps of "later date—either Cardan, or Budæus, or Petrarch, "or Stella—or poſſibly it may be ſome divine "or father of the Church, St. Auſtin, or St. "Cyprian, or Bernard, who affirms, that it is an "irreſiſtible and natural paſſion, to weep for the "loſs of our friends or children—and Seneca, "(I'm poſitive) tells us ſomewhere, that ſuch griefs "evacuate themſelves beſt by that particular channel. And accordingly, we find that David wept "for his ſon Abſalom—Adrian for his Antinous†—

"Niobe

* Anat. of Melanch. p. 213.

† The time has been, when this conjunction with the King of Iſrael would have ſmelt a little of the faggot.

" Niobe for her children—and that Apollodorus
" and Crito both ſhed tears for Socrates before his
" death." — This is well rallied, as the following paſſage will evince; but Sterne ſhould have conſidered how much he owed to poor old Burton.

" *Death and departure of friends are things generally grie-*
" *vous; Omnium quæ in vita humana contingunt, luctus*
" *atque mors ſunt acerbiſſima,* [Cardan. de Conſol.
" lib. 2.] *the moſt auſtere and bitter accidents that can*
" *happen to a man in this life, in æternum valedicere, to*
" *part for ever, to forſake the world and all our friends,*
" *'tis ultimum terribilium, the laſt and the greateſt terrour,*
" *moſt irkſome and troubleſome unto us, &c.—Nay many*
" *generous ſpirits, and grave ſtaid men otherwiſe, are ſo*
" *tender in this, that at the loſs of a dear friend they will*
" *cry out, roar, and tear their hair, lamenting ſome*
" *months after, howling O hone, as thoſe Iriſh women,*
" *and Greeks at their Graves, commit many indecent*
" *actions," &c.** All this is corroborated by quotations from Ortelius, Catullus, Virgil, Lucan and Tacitus. I take them in the order aſſigned them by Burton. For he ſays with great probability of himſelf, that he commonly wrote as faſt as poſſible, and poured out his quotations juſt as they happened to occur to his memory. But to proceed with Mr. Shandy's Conſolation.

" 'Tis

* Anat. of Melanch. p. 213.

" 'Tis an inevitable chance—the firſt ſtatute in
" Magna Charta—it is an everlaſting act of Par-
" liament, my dear brother—all muſt die."*

" *'Tis an inevitable chance, the firſt ſtatute in Magna*
" *Charta, an everlaſting act of Parliament, all muſt*
" *die.*†

" When Tully was bereft of his dear daughter
" Tullia, at firſt he laid it to his heart—he liſtened
" to the voice of Nature, and modulated his own
" unto it, &c.—But as ſoon as he began to look
" into the ſtores of Philoſophy, and conſider how
" many excellent things might be ſaid upon the
" occaſion—nobody upon earth can conceive, ſays
" the great orator, how joyful, how happy it made
" me."||

" *Tully was much grieved for his daughter Tulliola's*
" *death at firſt, until ſuch time that he had confirmed his*
" *mind with ſome philoſophical precepts, then he began to*
" *triumph over fortune and grief, and for her reception into*
" *heaven to be much more joyed than before he was troubled*
" *for her loſs.*"‡

Sterne is uncharitable here to poor Cicero.—

" Kingdoms and provinces, and towns and cities,
" have they not their periods?" Where is Troy,
and

* Triſtram Shandy, Vol 5th. Chap. 3.

† Anat. of Melancholy, p. 215.

|| Sterne.

‡ Burton.

" and Mycene, and Thebes, and Delos, and Perse-
" polis, and Agrigentum. - - - - What is become,
" brother Toby, of Nineveh, and Babylon, of
" Cyzicum and Mytilene; the fairest towns that
" ever the sun rose upon, are now no more."*

"*Kingdoms, Provinces, Towns and Cities,*" says Burton, "*have their periods, and are consumed. In those flourishing times of Troy, Mycene was the fairest city in Greece, - - - but it, alas, and that Assyrian Ninive are quite overthrown. The like fate hath that Egyptian and Bæotian Thebes, Delos, the common Council-house of Greece, and Babylon, the greatest City that ever the Sun shone on, hath now nothing but walls and rubbish left.*" - - - - *And where is Troy itself now, Persepolis, Carthage, Cizicum, Sparta, Argos, and all those Grecian Cities? Syracuse and Agrigentum, the fairest towns in Sicily, which had sometimes seven hundred thousand inhabitants, are now decayed.* Let us follow Sterne again. "Re-
" turning out of Asia, when I sailed from Ægina
" towards Megara, I began to view the Country
" round about. Ægina was behind me, Megara
" was before, Pyræus on the right hand, Corinth
" on the left. What flourishing towns now prostrate
" on the earth! Alas! alas! said I to myself,
" that a man should disturb his soul for the loss of
" a Child, when so much as this lies awfully buried
" in his presence. Remember, said I to myself
" again—remember that thou art a Man."

I This

* Sterne.

This is, with ſome ſlight variations, Burton's tranſlation of Servius's letter. Sterne alters juſt enough, to ſhew that he had not attended to the original. Burton's verſion follows.

" *Returning out of Aſia, when I ſailed from Ægina toward Megara, I began to view the Country round about. Ægina was behind me, Megara before, Pyræus on the right hand, Corinth on the left; what flouriſhing towns heretofore, now proſtrate and overwhelmed before mine eyes? Alas, why are we men ſo much diſquieted with the departure of a friend, whoſe life is much ſhorter? When ſo many goodly Cities lie buried before us. Remember, O Servius, thou art a Man; and with that I was much confirm'd, and corrected myſelf.*"

" My Son is dead," ſays Mr. Shandy, " ſo much " the better,* 'tis a ſhame, in ſuch a tempeſt, to " have but one Anchor."

I—but he was moſt dear and loving friend, quoth Burton, *my ſole friend—Thou maiſt be aſhamed, I ſay with Seneca, to confeſs it, in ſuch a tempeſt as this, to have but one anchor.*

" But," continues Mr. Shandy, " he is gone for " ever from us! be it ſo. He is got from under " the hands of his barber before he was bald. He " is but riſen from a feaſt before he was ſurfeited— " from a banquet before he had got drunken. The " Thracians wept when a child was born, and " feaſted and made merry when a man went " out

* This is an aukward member of the ſentence.

"out of the world, and with reaſon. Is it not "better not to hunger at all, than to eat? not to "thirſt, than to take phyſic to cure it? Is it not "better to be freed from cares and agues, love and "melancholy, and the other hot and cold fits of "life,† than, like a galled traveller, who comes "weary to his inn, to be bound to begin his journey "afreſh?"

I ſhall follow Burton's collections as they ſtand in his own order.‡ "*Thou doſt him great injury to deſire his longer life. Wilt thou have him crazed and ſickly ſtill, like a tired traveller that comes weary to his Inn, begin his journey afreſh? - - - he is now gone to eternity - - - - - as if he had riſen, ſaith Plutarch, from the midſt of a feaſt, before he was drunk - - - Is it not much better not to hunger at all, than to eat: not to thirſt, than to drink to ſatisfy thirſt; not to be cold, than to put on clothes to drive away cold? You had more need rejoice that I am freed from diſeaſes, agues, &c. The Thracians wept ſtill when a child was born, feaſted and made mirth when any man was buried: and ſo ſhould we rather be glad for ſuch as die well, that they are ſo happily freed from the miſeries of this life.*‖

† This approaches to one of Shakeſpeare's happy expreſſions:

> Duncan is in his grave:
> After *Life's fitful fever* he ſleeps well.

‡ Sterne has commonly reverſed the arrangement, which produces a ſtrong effect in the compariſon.

‖ Anat. of Mel. p. 216.

Again—" Confider, brother Toby,—when we are, death is not, and when death is, we are not"—So Burton tranflates a paffage in Seneca: *When we are, death is not; but when death is, then we are not.** The original words are, *quum nos fumus, mors non adeft; cum vero mors adeft, tum nos non fumus.*

" For this reafon, continued my father, 'tis " worthy to recollect, how little alteration in great " men the approaches of death have made. Vef- " pafian died in a jeft - - - - - - - - - Galba with a " fentence—Septimius Severus in a difpatch; Tibe- " rius in diffimulation, and Cæfar Auguftus in a " compliment." This conclufion of fo remarkable a Chapter is copied, omitting fome quotations, almoft verbatim, from Lord Verulam's Effay on Death.

We muft have recourfe to Burton again, for part of the Triftra-Pædia. " O bleffed health! cried " my father, making an exclamation, as he turned " over the leaves to the next Chapter,—thou art " above all gold and treafure; 'tis thou who en- " largeft the foul,—and openeft all its powers to " receive inftruction, and to relifh virtue.—He " that has thee, has little more to wifh for;—and " he that is fo wretched as to want thee,—wants " every thing with thee.†

O bleffed health! fays Burton, *thou art above all gold and*

* P. 213.

† Chap. 33, vol. 5.

and treaſure; [Eccleſiaſt.] *the poor man's riches, the rich man's bliſs, without thee there can be no happineſs.**

O beata ſanitas, te preſente, amœnum
Ver floret gratiis, abſque te nemo beatus.

But I ſhould, in order, have noticed firſt an exclamation at the end of Chapter ix. in the ſpirit of which no body could expect Sterne to be original. " Now I love you for this—and 'tis this " delicious mixture within you, which makes you " dear Creatures what you are—and he who hates " you for it—all I can ſay of the matter is, That " he has a pumpkin for his head, or a pippin for " his heart,—and whenever he is diſſected 'twill be " found ſo."—Burton's Quotation is: *Qui vim non ſenſit amoris, aut lapis eſt, aut bellua:* which he tranſlates thus: *He is not a man, a block, a very ſtone, aut Numen, aut Nebuchadnezzar, he hath a gourd for his head, a pippin for his heart, that hath not felt the power of it.*

In Chap 36, vol. vi. Sterne has picked out a few quotations from Burton's Eſſay on Love-Melancholy,† which afford nothing very remarkable except Sterne's boldneſs in quoting quotations.

By help of another extract‡ from Burton, Sterne makes a great figure as a curious Reader: " I hate " to make myſteries of nothing;—'tis the cold " cautiouſneſs

* Page 104. ibid. Page 276.

† See Burton, page 310, & ſeq.

‡ Triſt. Shandy, vol. vii. c. 13.

" cautiouſneſs of one of thoſe little ſouls from
" which Leſſius (lib. 13. de moribus divinis, ch.
" 24.) has made his eſtimate, wherein he ſetteth
" forth, That one Dutch mile, cubically multi-
" plied, will allow room enough, and to ſpare,
" for eight hundred thouſand millions, which he
" ſuppoſes to be as great a number of ſouls (count-
" ing from the fall of Adam) as can poſſibly be
" damn'd to the end of the world. - - - - I am
" much more at a loſs to know what could be
" in Franciſcus Ribera's head, who pretends that
" no leſs a ſpace than one of two hundred
" Italian miles, multiplied into itſelf, will be ſuffi-
" cient to hold the like number—he certainly muſt
" have gone upon ſome of the old Roman ſouls,"
&c.

The ſucceeding raillery is very well, but unfair with reſpect to the mathematical Theologiſt, as the original paſſage will prove. " *Franciſcus Ribera, in cap.* 14. *Apocalypſ. will have Hell a material and local fire in the centre of the earth,* 200 *Italian miles in diameter, as he defines it out of thoſe words, Exivit ſanguis de terra—per Stadia mille ſexcenta, &c. But Leſſius, lib.* 13. *de moribus divinis, cap.* 24. *will have this local hell far leſs, one Dutch mile in diameter, all filled with fire and brimſtone; becauſe, as he there demonſtrates, that ſpace cubically multiplied will make a ſphere able to hold eight hundred thouſand millions of damned bodies, (allowing each body ſix foot ſquare) which will abundantly ſuffice.*" [I believe the damn'd, upon Leſſius's ſcheme, would be leſs crouded

crouded, than the victims of the African Slave-trade have often been, on the middle paſſage.] "*Cum certum ſit, inquit, facta ſubductione, non futuros centies mille milliones damnandorum.**

Again, at the end of the ſame Chapter in Triſtram Shandy; "but where am I? and into what a "delicious riot of things am I ruſhing? I—I who "muſt be cut ſhort in the midſt of my days," &c. Burton concludes his Chapter "on Maids', Nunns', "and Widows' Melancholy," in the ſame manner. "*But where am I? into what ſubject have I ruſhed? What have I to do?*"† *&c.*

I ſhall juſt obſerve by the way, that a pretty paſſage in the *Story of the King of Bohemia and his ſeven caſtles*;—"MODESTY ſcarce touches with a "finger what LIBERALITY offers her with both hands "open"—alludes to a picture of Guido's, the deſign of which it deſcribes tolerably well.

Retournons a nos moutons, as Rabelais would ſay; in matters of painting, it is dangerous for a man to truſt his own eyes, till he has taken his degree of Connoiſſeur.

It confirms me ſtrongly in the belief that the character of Mr. Shandy is a perſonification of the authorſhip of Burton, when I find ſuch a paſſage as the following in Sterne. "There is a Philippic in "verſe on ſomebody's eye or other, that for two "or

* Anat. of Melanch. p. 156.

† Page 124.

" or three nights together had put him by his reſt;
" which, in his firſt tranſport of reſentment againſt
" it, he begins thus:

> " A Devil 'tis—and miſchief ſuch doth work,
> " As never yet did Pagan, Jew, or Turk."

This choice couplet is quoted by Burton* from ſome bad Poet, now unknown, of whoſe name he only gives the initials.

" Hilarion the hermit, in ſpeaking of his abſti-
" nence, his watchings, flagellations, and other
" inſtrumental parts of his religion,—would ſay—
" tho' with more facetiouſneſs than became an
" hermit—That they were the means he uſed, to
" make his aſs (meaning his body) leave off kick-
" ing."†

" *By this means Hilarion made his Aſs, as he call'd his own body, leave kicking (ſo Hierome relates of him in his life) when the Devil tempted him to any foul offence.*"‡

" I wiſh, Yorick, ſaid my father, you had read
" Plato; for there you would have learnt that there
" are two Loves— --- of theſe Loves, according
" to Ficinus's comment upon Velaſius, the one is
" rational—the other is natural—the firſt ancient—
" without

* Page 331.

† Tr. Shandy, vol. viii. chap. 31.

‡ Burton, p. 333.

"without mother—where Venus has nothing to "do: the ſecond, begotten of Jupiter and "Dione—"*

† *One Venus is ancient, without a Mother, and deſcended from Heaven, whom we call cœleſtial. The younger begotten of Jupiter and Dione, whom commonly we call Venus. Ficinus, in his comment upon this place, cap* 8. *following Plato, called theſe two loves, two Devils, or good and bad Angels according to us, which are ſtill hovering about our ſouls* ‡

That part of the letter to Uncle Toby, which conſiſts of obſolete medical practices, is taken from one of the Chapters on the Cure of Love-Melancholy.|| Many curious quotations might be added to what Sterne knew, out of Dr. Ferrand's Erätomania; but this Eſſay is already long enough.

There is another writer, whoſe pathetic manner Sterne ſeems to have caught; it is Marivaux,—the father of the ſentimental ſtyle. A careful peruſal of his writings, and of thoſe of the younger Crebillon, might perhaps elucidate the ſerious parts of Triſtram Shandy, and the Sentimental Journey. But I muſt leave this undertaking to thoſe who have ſufficient time to ſacrifice to the taſk. From theſe

K Authors,

* Tr. Shandy, vol. viii. chap. 33.

† Velaſius is quoted thro' all the preceding paſſages in Burton.

‡ P. 260.

|| P. 333 to 335.

Authors, I think, Sterne learnt to practice what Quintilian had made a precept: Minus eſt TOTUM dicere quam OMNIA. With genius enough for the attempt, one has frequently failed in producing pleaſure by the length of his digreſſions, and the other by affecting an exceſſive refinement and ambiguity in his language. *Les bons écrivains du ſiècle de Louis XIV.* ſays Voltaire, *ont eu de la force, aujourd'hui on cherche de Contorſions.* Our own writers are not free from this error; and it would not be unworthy their conſideration, that a ſentence, which is ſo much refined as to admit of ſeveral different ſenſes, may perhaps have no direct claim to any ſenſe.* Sterne has ſeldom indulged theſe lapſes, for which he was probably indebted to the buoyant force of Burton's firm Old-Engliſh ſinews.

Whoever will take the trouble of comparing Sterne's Dialogue with his own feelings, in the Sentimental

* Maynard puts this very well:

Mon ami, chaſſe bien loin
Cette noire Rhetorique,
Tes ouvrages ont beſoin
D'un devin qui les explique.
Si ton eſprit veut cacher
Les belles choſes qu'il penſe,
Di-moi, qui peut t'empêcher
De te ſervir du ſilence?

Sentimental Journey,† to that of Jacob with his Avarice and his Honour, in the firſt part of the Payſan Parvenu, will perceive a near reſemblance. It would be cruel to inſert the French declamation. A ſhorter paſſage from the ſame work will ſhew that the Shandean manner is very ſimilar to that of Marivaux.

Le Directeur avoit laiſſe parler l'aineè ſans l'interrompre, & ſembloit meme un peu piqué de l'obſtination de l'autre.

Prenant pourtant un air tranquille et benin : ma chere Demoiſelle, ecoutez moi, dit il à cette cadette; vous ſavez avec quelle affection particuliere je vous donne mes conſeils à toutes deux.

Ces derniers paroles, à toutes deux, furent partagèes, de façon que la Cadette en avoit pour le moins les trois quarts & demi pour elle, et ce ne fut meme que par reflexion ſubite, qu'il en donna le reſte à l'aineè.‡

The curious hypotheſis reſpecting Chriſtian names, contains a juſt ſatire on what was once a popular ſuperſtition, and even cheriſhed by the learned.

K 2 Paſquier,

† Compare alſo the firſt Converſation with Me. Freval, in the Payſan Parvenu, with a ſcene in the Sentimental Journey. Wherever Sterne picked up his Fragment, as he calls it, in the Sentimental Journey, on the power of Love, it is evidently ill-copied from the exordium of Lucian's admirable eſſay on the method of writing Hiſtory.

‡ Payſan Parvenu, Partie, 2me.

Pafquier, in his *Recherches*, has a Chapter on the fortune of fome Chriftian Names. In the prefent ftate of knowledge, it would be unpardonable to omit a remark, with which an author like Sterne would make himfelf very merry. It relates to the paffage, in which Mr. Shandy treats the name of TRISTRAM with fuch indignity, and demands of his fuppofed Adverfary, "Whether he had ever "remembered,—whether he had ever read,—or "whether he had ever heard tell of a man, call'd "Triftram, performing any thing great or worth "recording?—No,—he would fay,—TRISTRAM!— "The thing is impoffible!" A Student of the fafhionable black-letter erudition would have triumphed in proclaiming the redoubted Sir Triftram, Knight of the Round-table, and one of the moft famous knights-errant upon record. Sterne might have replied:

> Non fcribit, cujus Carmina nemo legit;*

and indeed his pleafant hero has no refemblance to the *preux Chevalier*.

I am forry to deprive Sterne of the following pretty figure, but juftice muft be done to every one.

"In fhort, my father - - - - - - advanced fo very "flowly with his work, and I began to live and "get forward at fuch a rate, that if an event had "not

* Martial, Lib. 2.

" not happened -- &c. I verily believe I had
" put by my father, and left him drawing a sun-
" dial, for no better purpose than to be buried
" under ground."*

Donne concludes his poem entitled The Will, with this very thought:

> And all your Graces no more use shall have
> Than a Sun-dial in a Grave.

There is a strange coincidence between Sterne and a mystic writer, in the insertion of a black page in each of their works. I cannot consider it as an imitation, for it must appear by this time, that Sterne possessed no great store of curious reading.

Every one knows the black pages in Tristram Shandy; that of prior date is to be found in Dr. Fludd's *Utriusque cosmi Historia*,† and is emblematic of the Chaos. Fludd was a man of extensive erudition, and considerable observation, but his fancy, naturally vigorous, was fermented and depraved, by astrological and Cabbalistic researches. It will afford a proof of his strange fancies, and at the same time do away all suspicion of Sterne in this instance, to quote the ludicrous coincidence mentioned by Morhoff, between himself and this Author. " Cogitandi modum in nobis et speculationes illas rationum, mirificè quodam in loco, videlicet in libro

* Tr. Shandy, vol v. chap. 16.

† Page 26.

libro *de myſtica cerebri anatome* [Fluddius] ob oculos ponit. Solent ab anatomicis illic delineari genitalia membra, utriuſque ſexus, quod proceſſus quidam et ſinus, eum in modum figurati ſunt. Hic Fluddius invenit, non quod pueri in faba, illic dicit generari cogitatione ; quod mihi mirum viſum eſt, cum ego aliqua do joculare carmen *de Ente rationis* ſcriberem, et, ferente ita genio carminis, joci gratia finxiſſem, illic generari Entia rationis, poſtea cum incidi in iſtud Fluddii, quod ne ſomniando quidem cogitaeram, inveniſſe me, ſerio hæc aſſeri a Fluddio."*

I am not acquainted with the foundation of the curious paſſages reſpecting the poſſibility of baptizing infants *in utero*,† but I find that Mauriceau adverts to the circumſtance, in his attack on the Cæſarian operation: "il n'y a pas d'occaſions ou "on ne puiſſe bien donner le Baptême à l'enfant, "durant qu'il eſt encore au ventre de la mere, "eſtant facile de porter de l'eau nette par le moyen "du Canon d'une ſeringue juſques ſur quelque "partie de ſon Corps"—He then obviates a difficulty unthought of by Sterne's Doctors; which perſuades me that this paſſage of Mauriceau had not occurred to him—"et il ſeroit inutile d'alleguer que l'eau "n'y peut pas etre conduite, à cauſe que l'enfant "eſt envelopé de ſes membranes, qui en empêchent; "car

* Morhoff. Polyhiſt. Philoſ. lib. ii. p. 1. cap. 15.

† Triſtram Shandy, vol. i. chap. xx.

" car ne fçait-onpas qu'on les peut rompre tres
" aifément, en cas qu'elles ne fe fuffent pas, apres
" quo on peut toucher effectivement fon Corps."*

This writer has alfo mentioned the mifchievous effect of ftrong preffure applied to the heads of very young Children; which is connected with another theory that Sterne has diverted himfelf with. I have not met with the original of it in my reading, but will give a paffage from Bulwer's Anthropometamorphofis, analogous to Mauriceau's. †

The North-weft paffage to Learning, obfcurely mentioned in the Triftra-Pædia, is defcribed by Dr. Warton, in his excellent obfervations on the Genius and Writings of Pope, and was well burlefqued by Swift, in the Voyage to Laputa.‡

The

*Mauric. Maladies des Femmes Groffes, p. 347 (edit. 3me. 4to. 1681.)

† I knew a Gentleman who had divers fons, and the Midwives and Nurfes had with headbands and ftrokings fo alter'd the natural mould of their heads, that they proved children of a very weak underftanding. His laft fon only, upon advice given him, had no reftraint impofed upon the natural growth of his head, but was left free from the coercive power of headbands and other artificial violence, whofe head, although it were bigger, yet he had more wit and uuderftanding than them all.

Artificial Changeling, p. 42.

‡ See the Defcription and Print of the literary turning Machine.

The beſt Commentary on Chap. 5, vol. 8th. is Montagne's eſſay on the ſubject.

There is one paſſage in the 7th. volume, which the circumſtances of Sterne's death render pathetic. A believer in the doctrine of Pre-ſentiment would think it a prop to his theory. It is as ſtriking as Swift's Digreſſion on Madneſs, in the Tale of a Tub.

"Was I in a condition to ſtipulate with Death
"---- I ſhould certainly declare againſt ſubmitting
" to it before my friends; and therefore I never
" ſeriouſly think upon the mode and manner of
" this great cataſtrophe, which generally takes up
" and torments my thoughts as much as the cataſ-
" trophe itſelf, but I conſtantly draw the curtain
" acroſs it with this wiſh, that the Diſpoſer of all
" things may ſo order it, that it happen not to
" me in my own houſe—but rather in ſome decent
" inn—---- in an inn, the few cold offices I
" wanted, would be purchaſed with a few guineas,
" and paid me with an undiſturbed but punctual
" attention." It is known that Sterne died in hired lodgings, and I have been told, that his attendants robbed him even of his gold ſleeve-buttons, while he was expiring.

I have ſeen, not very long ago, a charge of plagiariſm brought againſt Sterne, reſpecting his Sermons.

From what Author the paſſages were ſaid to be borrowed, I do not remember; but it has long been my

my opinion, that the manner, the ſtyle, and the ſelection of ſubjects for thoſe Sermons, were derived from the excellent *Contemplations* of Biſhop Hall. There is a delicacy of thought, and tenderneſs of expreſſion in the good Biſhop's compoſitions, from the transfuſion of which Sterne looked for immortality.

Let us compare that ſingular Sermon, entitled THE LEVITE AND HIS CONCUBINE, with part of the Biſhop's Contemplation of the LEVITE'S CONCUBINE. I ſhall follow Sterne's order.

"— Then ſhame and grief go with her, and "wherever ſhe ſeeks a ſhelter, may the hand of "juſtice ſhut the door againſt her."*

What huſband would not have ſaid—She is gone, let ſhame and grief go with her; I ſhall find one no leſs pleaſſing, and more faithful.†

"Our annotators tell us, that in Jewiſh *œconomicks*, theſe (concubines) differed little from "the wife, except in ſome outward ceremonies and "ſtipulations, but agreed with her in all the true "eſſences of marriage."‡

The Law of God, ſays the Biſhop, *allowed the Levite a wife; human connivance a concubine; neither did the Jewiſh concubine differ from a wife, but in ſome outward compliments; both might challenge all the true eſſence of marriage.*

L I

* Sterne, Sermon xviii.

† Bp. Hall's Works, p. 1017.

‡ Sterne loc. citat.

I ſhall omit the greater part of the Levite's ſoliloquy, in Sterne, and only take the laſt ſentences.

" Mercy well becomes the heart of all thy
" creatures, but moſt of thy ſervant, a Levite,
" who offers up ſo many daily ſacrifices to thee,
" for the tranſgreſſions of thy people."

— " But to little purpoſe," he would add, " have
" I ſerved at thy altar, where my buſineſs was to
" ſue for mercy, had I not learn'd to practiſe it.

Mercy, ſays Bp. Hall, *becomes well the heart of any man, but moſt of a Levite. He that had helped to offer ſo many ſacrifices to God for the multitude of every Iſraelite's ſins, ſaw how proportionable it was, that man ſhould not hold one ſin unpardonable. He had ſerved at the altar to no purpoſe, if he (whoſe trade was to ſue for mercy) had not at all learned to practiſe it.*

It were needleſs to purſue the parallel.

Sterne's twelfth Sermon, on the Forgiveneſs of Injuries, is merely a dilated Commentary on the beautiful concluſion of the *Contemplation* 'of Joſeph.'

The ſixteenth Sermon contains a more ſtriking imitation. " There is no ſmall degree of malicious
" craft in fixing upon a Seaſon to give a mark of
" enmity and ill-will; — a word, a look, which,
" at one time, would make no impreſſion, — at
" another time, wounds the heart; and, like a
" ſhaft flying with the wind, pierces deep, which,
" with its own natural force, would ſcarce have reached
" the object aimed at."

This

This is little varied from the original: *There is no ſmall cruelty in the picking out of a time for miſchief; that word would ſcarce gall at one ſeaſon, which at another killeth. The ſame ſhaft flying with the wind pierces deep, which againſt it, can hardly find ſtrength to ſtick upright.**

In Sterne's fifth Sermon, the *Contemplation* of Elijah with the Sareptan,' is cloſely followed. Witneſs this paſſage out of others: "The Prophet "follows the call of his God:—the ſame hand "which brought him to the gate of the city, had "led alſo the poor widow out of her doors, op-"preſſed with ſorrow."†

The Prophet follows the call of his God; the ſame hand that brought him to the gate of Sarepta, led alſo this poor widow out of her doors.‡

The ſucceeding paſſages which correſpond are too long for inſertion.

Sterne has acknowledged his acquaintance with this book, by the diſingenuity of two ludicrous quotations in Triſtram Shandy.||

What aſſiſtance the writings of Voltaire and Rouſſeau afforded Sterne, I omit to enquire. The former was the firſt author of this age, who introduced the terms and operations of the modern art of war into works of entertainment; but Sterne's military ardour ſeems to have been inſpired by the prolix details of honeſt Tindal. Voltaire himſelf reviewed the firſt volumes of Triſtram Shandy,

* Hall's Shimei Curſing. † Sterne.

‡ Bp. Hall, P. 1323. || Vol. 1. Chap. 22. and Vol. 7. Chap. 13

Shandy, in one of the foreign Journals, and did not charge their author with the imitation of any perſon but Rabelais and Swift. He was probably not very jealous of the reputation of a modern Engliſh writer.

Such are the caſual notes, with the collection of which I have ſometimes diverted a vacant half-hour. They leave Sterne in poſſeſſion of every praiſe but that of curious erudition, to which he had no great pretence, and of unparellelled originality, which ignorance only can aſcribe to any poliſhed writer. It would be enjoining an impoſſible taſk, to exact much knowledge on ſubjects frequently treated, and yet to prohibit the uſe of thoughts and expreſſions rendered familiar by ſtudy, merely becauſe they had been occupied by former Authors. There is a kind of imitation which the Ancients encouraged ,and which even our Gothic Criticiſm admits, when acknowledged. But juſtice cannot permit the Polygraphic Copy to be celebrated at the expence of the Original.

Voltaire has compared the merits of Rabelais and Sterne, as Satiriſts of the Abuſe of Learning, and, I think, has done neither of them juſtice. This great diſtinction is obvious; that Rabelais derided abſurdities then exiſting in full force, and intermingled much ſterling ſenſe with the groſſeſt parts of his book; Sterne, on the contrary, laughs at many exploded opinions, and abandoned fooleries, and contrives to degrade ſome of his moſt

ſolemn

ſolemn paſſages by a vicious levity. Rabelais flew a higher pitch, too, than Sterne. Great part of the voyage to the *Pays de Lanternois*,* which ſo ſeverely ſtigmatizes the vices of the Romiſh Clergy of that age, was performed in more hazard of fire than water.

The follies of the Learned may as juſtly be corrected, as the vices of Hypocrites; but for the former Ridicule is a ſufficient puniſhment. Ridicule is even more effectual to this purpoſe, as well as more agreeable than ſcurrility, which is generally preferred, notwithſtanding, by the learned themſelves in their conteſts, becauſe Anger ſeizes the readieſt weapons;

Jamque faces et ſaxa volant; furor arma miniſtrat:

And where a little extraordinary Power has accidentally been lodged in the hands of diſputants, they have not ſcrupled to employ the moſt cogent methods of convincing their adverſaries. Dionyſius the Younger ſent thoſe Critics who diſliked his verſes, to work in the Quarries;† and there was a pleaſant Tyrant, mentioned by Horace, who obliged his deficient debtors to hear him read his own Compoſitions, *amaras hiſtorias*, by way of commutation. I ſay nothing of the "holy faith of pike and

* I do not recollect to have ſeen it obſerved by Rabelais's Commentators, that this name, as well as the plan of the Satire, is imitated from Lucian's *True Hiſtory*. Lucian's town is called Lychnopolis.

† Plutarch.

and gun," nor of the ſtrong cudgel with which Luther terminated a theological diſpute, as I deſire to avoid Religious Controverſy. But it is impoſſible, on this ſubject, to forget the once celebrated Dempſter, the laſt of the formidable ſect of Hoplomachis, who fought every day, at his School in Paris, either with ſword or fiſt, in defence of his doctrines in omni ſcibili.‡ The impriſonment of Galileo, and the example of Jordano Bruno, burnt alive for aſſerting the Plurality of Worlds,‖ among other diſgraceful inſtances, ſhew that Laughter is the beſt criſis of an ardent diſputation.

The talents for ſo delicate an office as that of a literary Cenſor, are too great and numerous to be often aſſembled in one perſon. Rabelais wanted decency, Sterne learning, and Voltaire fidelity. Lucian alone ſupported the character properly, in thoſe pieces which appear to be juſtly aſcribed to him. As the narrowneſs of Party yet infeſts Philoſophy, a writer with his qualifications would ſtill do good ſervice in the Cauſe of Truth. For wit and good ſenſe united, as in him they eminently were, can attack nothing ſucceſsfully which ought not to be demoliſhed.

An

‡ Jan. Nic. Erythræ. Pinacothie:

‖ . Brucker. Hiſt. Critic. Philoſoph. Tom. v. P. 28, 29. The famous Scioppius publiſhed a ſhocking letter of exultation on this execution.

An Account of, and Obſervations on, different Blue Colours, *produced from the Mother Water of Soda Phoſphorata, &c. by Mr.* Thomas Willis, *of* London. — *Communicated by* Thomas Henry, *F. R. S. &c.*

To Mr. THOMAS HENRY.

Sir,

I requeſt the favour of you, to lay before the Society the incloſed Paper (containing an Account of, and Obſervations on different blue Colours, produced from the Mother-waters of Soda Phoſphorata) for their inſpection, and ſhall be much honoured if it ſhould merit their approbation.

The colour No. 1, ſeems to be a ſort of Pruſſian blue, but is much cloſer in its texture, and on breaking it, appears ſomewhat gloſſy.

As three of theſe colours are in the hands of different Painters, ſhould they prove uſeful, I ſhall take the earlieſt opportunity of communicating the intelligence to the Society.

I am, Sir,

Your moſt obliged and obedt. ſervant,

April 12, 1791. THOs. WILLIS.

An ACCOUNT, &c.

ACCIDENT led to the discovery of these Colours, which it is to be hoped will be found useful in the art of painting. Two of them have something of the appearance of Prussian blue, but from the following investigations there seems to be some other principle besides Phlogisticated Alcali for their basis; which I must confess I am not able to account for, but leave it to the judgment of Gentlemen of greater abilities than I can pretend to.

After I had extracted all the Chrystals of Soda Phosphorata from a combination of the Phosphoric Acid with pure mineral Alcali, or with the best Spanish Barilla freed from as much common salt as possible, I generally threw away the Mother-water as useless, which being poured through an iron grating, some of it was scattered about, and appeared of a blueish colour on the contiguous stones: upon which appearance, imagining it to proceed from a Phlogisticated Alkali, I dissolved four ounces of common alum and one ounce of martial vitriol in two quarts of water, by boiling them together. On some of the Mother-water of Soda Phosphorata was poured a little of the aluminous and martial solution: at first a greyish coagulum only was formed;

formed; but upon adding more of the folution, a fine blue colour was produced which readily precipitated. This being wafhed frequently with water till the fupernatant liquor was quite taftelefs, was then dried, and produced the colour No. 1.

As I was defirous of feeing whether Roch Alum would have any different effect, four ounces of Roch Alum and one ounce of Martial Vitriol were diffolved in two quarts of water, by boiling them together, and with fome of this folution a precipitate from the Mother-water of Soda Phofphorata was produced, which, after it was well wafhed, yielded the blue Colour No. 2, which is of a very pale hue.

A fmall quantity of thefe powders was given to a perfon that paints in water colours, who on trying them faid they were too fpongy for that purpofe.

As there was a very copious, light precipitate produced in the above two experiments, and the colouring matter, when dried, but fmall in quantity; I evaporated the Mother-water of Soda Phofphorata to a thick pellicle, and a deliquefcent falt was produced: the remaining liquor was precipitated with a folution of common Alum and Martial Vitriol, made with the proportions above-mentioned. A precipitate, not fo light as the two others, and in appearance lefs in quantity, was produced, but which, when wafhed and dried, yielded about the fame weight as the others. It was of a paler blue than the firft production, but of a bright colour; fome of which is contained in the paper marked No. 1, with a +.

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This has not yet been tried as a water colour, nor have I received any account of their being ufeful oil-colours, although I have given fome of each of them to different Painters, as alfo a portion of fome of the next preparation.

Thinking that the Aluminous Earth was the reafon of the fponginefs of the colours, when ufed as water colours, I thought, by precipitating the Mother-water of Soda Phofphorata with a martial folution alone, it might produce a colour free from that fponginefs complained of; therefore I added to the Mother-water above-mentioned, a faturated folution of Martial Vitriol, and a very copious precipitate was formed, but of a lefs beautiful colour than either the firft or third. The precipitate was very light, and required fome length of time to fettle: it was wafhed till perfectly taftelefs, and although it occupied much fpace, being fo very expanfive, it yielded a lefs proportion of dry colour than either of the former proceffes, and was not fo deep a blue as No. 1.

As this laft colour, when dried, had a little brownifh tinge on its furface, I concluded it proceeded from its having fome ochry matter mixed with it; to free it from which, I added a little Oil of Vitriol to a fmall portion of it, and the whole became of a dirty green, which, on being poured into water, turned of a deep blue. This was well wafhed to free it from all acidity; but the colour did not appear to be improved.

In

In order to examine whence this colouring matter proceeded, the following experiments were made:

1ſt. Some pure Soda Phoſphorata was diſſolved, to which was added a portion of the aluminous and martial ſolution. A dirty white coagulum was formed, which, by adding more of the precipitating liquor, was rediſſolved entirely.

2d. To ſome of the ſame ſolution of Soda Phoſphorata was added a ſolution of Martial Vitriol: a ſimilar coloured coagulum appeared, of which, upon ſurcharging it with the latter ſolution, the greateſt part was rediſſolved, and the remainder continued unchanged in colour.

3d. With Sal Soda diſſolved in water, the aluminous and martial ſolution precipitated a dirty white colour, which being overcharged with the precipitating liquor, part was rediſſolved; but what remained was not altered in colour.

4th. Some of the ſame ſolution of Sal Soda was precipitated with a ſolution of vitriolated iron: a very large quantity of brown precipitate was produced, which being overcharged with the ſolution of iron, effervefced much, and the precipitate was rediſſolved.

This experiment was ſome time afterwards made with another ſolution of Sal Soda, and the ſolution of vitriolated iron: when a ſimilar coloured precipitate was produced, but being overcharged with the latter, only part of the precipitate was rediſſolved, but there was no alteration of colour.

5th. The Mother-water of Sal Soda, precipitated with the aluminous and martial ſolution, gave at firſt a dirty brown colour, which did not diſſolve, but upon ſuperſaturation was changed to a pale blue colour: but this was only from one parcel of the Mother-water of Sal Soda; for on trying various other Mother-waters of Sal Soda, very different productions were obtained. From ſome a dirty brown, from others a dirty white, from others a grey. The beſt colour that was produced is the ſmall quantity ſent, marked No. 3. As the Barilla that is brought from Spain is very unequal in its ſtrength and quantity, the difference of the precipitates is not much to be wondered at.

6th. With the ſame Mother-water as mentioned in the 5th. experiment, and a ſolution of martial vitriol, much the ſame effect was produced, only a leſs copious precipitate, and of a paler colour, but, in ſeveral other trials, on various other Mother-waters of Sal Soda, generally a brown coloured precipitate was produced.

7th. The pure Mineral Alkali from the Eaſt-Indies, diſſolved in water, and precipitated with the Aluminous and Martial Solution, formed a dirty white precipitate, which being overcharged with the precipitating liquor, effervеſced very much. Part of the precipitate was re-diſſolved, and the remainder retained its colour.

8th. To the ſame Solution of Mineral Alcali mentioned in the 7th. Experiment, was added a Solution of

of Vitriolated Iron. A large quantity of olive-green coagulum appeared. Upon ſuperſaturating it, a great effervefcence was excited and the whole of the coagulum was re-diſſolved, yielding a browniſh green, diaphanous liquor, but upon ſtanding all night in the glaſs veſſel, a browniſh-green precipitate fell down.

9th. The Acid of Phoſphorus was added to the Aluminous and Martial Solution, and it gave a pale white precipitate.

10th. The Acid of Phoſphorus being added to the Solution of Vitriol of Iron, no decompoſition took place.

It appears that from the Mother-water produced from the combination of the Phoſphoric Acid and Mineral Alkali, a blue colour is *always* obtained by means of a martial Solution; and that from the Mother-water of Sal Soda it is uncertain, and what is produced is of a pale colour; and that this fact might be more ſatisfactorily aſcertained, the Mother-waters of Sal Soda, that were uſed, were thoſe from which the Salt had been extracted to make the Soda Phoſphorata, whoſe Mother-waters were tried in theſe experiments.

It is true alſo that the Mother-water of tartarized Natron will ſometimes yield a Pruſſian blue, but not always, and whenever it does, it is generally pale-coloured; but in all the experiments made with the Phoſphorated Alkaline Mother-waters above related, a deep blue colour has been produced, except

except in the ſingle one made with Rock Allum; for the other operations have been repeated, and the reſults have been uniform.

The Acid of Phoſphorus has been tried with the two precipitating liquors, and no blue colour was produced. It therefore remains to account, how this blue colour ſhould be continually produced by the combination above-mentioned, eſpecially as the phoſphoric Acid was obtained from bones burned to a perfect whiteneſs, which might be expected to deſtroy the tinging principle.

Some of the beſt Pruſſian blue that could be purchaſed, was added to the ſtrong Vitriolic Acid. It was changed to a green colour, but much paler than that produced from the colour precipitated by the Martial Solution, as above related, by adding the Acid of Vitriol to it; but on diluting the Pruſſian blue, digeſted in the Vitriolic Acid, with water, a large quantity of white powder was perceived, which evidently muſt be the Earth of Alum. Upon further diluting and ſtirring the mixture, it readily mixed with the tinging matter, and appeared uniformly blended therewith.

A portion of the blue colour, No. 1. was likewiſe digeſted with ſtrong Vitriolic Acid. It was changed to a darker green colour than in the laſt mentioned proceſs, but on diluting it with water, it changed uniformly to blue: but on digeſting ſome of No. 2 with the Vitriolic Acid, there was a ſeparation when the mixture was diluted with

water;

water; at firſt the mixture was of a deeper green than that with the Pruſſian blue digeſted in Vitriolic Acid; and upon diluting it, at firſt the liquor altered but little; yet, in the ſpace of half a minute it became of a deeper blue than the original, but a large quantity of a dirty white coloured matter was ſeparated.

It alſo appears, that there is very little difference between the pure mineral Alkali brought from the Eaſt-Indies, and the beſt Spaniſh Barilla, when it is freed as much as poſſible from common Salt.

From the deep colouring matter ſeparating on the dilution of Pruſſian blue, digeſted with Vitriolic Acid, by adding water to it, Quere, Whether a much finer blue might not be produced by pouring off that blue liquor from the white powder, and edulcorating it?

On

On the Impreſſion of Reality attending Dramatic Repreſentations, by J. Aikin, M. D.—*Communicated by* Dr. Percival.

Read October 7.

DR. Johnſon, in his Preface to Shakeſpear, excuſes that great poet's violation of the *Dramatic Unities*, and argues againſt the law by which they have been enjoined, upon this principle—That as, in fact, we are never ſo deceived by a dramatic repreſentation, as to believe it *real*, there is no danger of injuring its effect by any thing which may tend to deſtroy ſuch a belief. And he ſeems to triumph not a little, in expoſing the abſurdity of an imagined conviction, that a ſcene paſſing before our eyes is *real*, when we are all the time conſcious that it began in fiction.

But it appears to me, that in this inſtance (as perhaps in many others) the critic has taken a very narrow ſurvey of the human mind, and has only ſkimmed the ſurface for that truth which lay ſomewhat deeper. The queſtion reſpecting the nature of that feeling which a ſcene of fiction excites in us, muſt be determined by a reference to the general mode in which the mind receives impreſſions. Now, I ſhall attempt to ſhew, that although the

the means by which emotions are raifed are very various, yet that, when raifed, they are all precifely the fame in their nature, and only differ in degree of intenfity. This, I think, will manifeftly appear, if, in the firft place, the fame principle which is neceffary to account for the effect of one of thefe means, will equally account for all; and, in the fecond place, if the evident and external expreffions of our emotions are fimilar in every cafe.

Why is it that the view of a *real* fcene of diftrefs, in which we are not perfonally concerned, operates upon our feelings, but in confequence of that general principle of our nature, whereby the image of human paffions in another, excites correfponding emotions in ourfelves? *Reality* itfelf cannot operate upon us without a *medium*; and in what refpect does the action produced by the direct medium of the fenfes, differ from that produced by the remoter mediums of recollection, narration, or any mode of fictitious reprefentation? I behold a perfon fuffering under the extremity of torture, and find myfelf highly affected at the fpectacle. I make his feelings in fome refpect my own;—my flefh creeps upon my bones, and the pain of fympathy rifes to fuch a degree as to become intolerable. It is now over, and that portion of human mifery has no longer an exiftence. Still the fcene recurs to my mind, and whenever it intrudes, all my pain is renewed, though with lefs intenfity; and this continues to be the cafe till the ideas fade away. The

 identity

identity of the fenfation is proved by the famenefs of the corporeal effects. If I fhuddered and turned pale at the real fpectacle, I do the fame at the firft recollections: if I ran with horror from the former, I plunge into company or bufinefs to deliver me from the latter. Now, if it be allowed, that my own mind, acting upon itfelf, without the aid of external objects, be capable of creating an imaginary fcene indiftinguifhable in its effects from a real one, why fhould not equal power be granted to thofe artificial methods, in which refembling, fenfible objects are called in to affift the operations of the fancy?

But, it may be faid, no one denies as a matter of fact, the power of recollection and fictitious reprefentation to move the paffions, and the queftion is only, what is neceffary to the production of this effect? Now, fince in the cafe of a recollected fcene, it cannot be a *belief of reality*, (for no man *believes* that the event on which he reflects is acted over again) why fhould fuch *belief* have any thing more to do with the efficacy of fiction? And this reafoning (on which Dr. Johnfon diffufely dwells) is juft, as far as it goes; but his error confifts in confounding with *proper belief*, that *impreffion of reality*, or *temporary illufion*, which I conceive abfolutely effential to account for the undoubted effects produced by all the various *imitations of action*. *Belief* is the confequence of a reflex operation of the mind, by which we are convinced of a truth after examination or

enquiry.

enquiry. It is therefore incompatible with the impreffions of illufion; for, as foon as they are examined, they are at an end. We cannot afk ourfelves whether they are true, without difcovering them to be falfe. But it is certain we are often fo impreffed with a notion, as to entertain no prefent *doubts* about it, though it is no object of our *belief*, but, on the contrary, has repeatedly been detected by us as a falfehood.

Dr. Johnfon himfelf, fpeaking of what he terms the *extrufion* of Glofter's eyes in Lear, fays, that it "feems an act too horrid to be endured in dramatic "exhibition, and fuch as muft always compel the "mind to relieve its diftrefs by incredulity." Does not this exprefsly imply, that a *lefs* horrid and unnatural action would pafs on the ftage for real; and that the ufual affection of the mind in dramatic exhibitions is an impreffion of reality? *Hiftorical incredulity* cannot be here meant; for how are we fure that the ftory was *not* true? befides, we read with tolerable tranquillity of facts ftill more fhocking. It muft then be the "incredulus odi" of Horace,—a refolution to difcard and reject what fo much pains us. Horace did not difbelieve that Medea had murdered her children; but when the fact was reprefented to him in a vifible difplay, the horror he felt made him refufe to admit it as a true fcene.

Further to elucidate this idea of the *impreffion of reality* as diftinct from *belief*, let us trace the progrefs of the imagination from the inftances in which it is

leaft

leaſt aſſiſted by external objects, to thoſe in which it is *moſt* ſo. And, not to dwell upon the conviction of reality attending dreams, delirium, and inſanity, where there is probably a phyſical cauſe operating on the brain, I ſhall firſt conſider the caſe of a reverie, or day-dream.

Sitting alone in my ſtudy, I ſhut my book, lean back in my chair, and following, either involuntarily or with deſign, a particular train of ideas, ſoon become inſenſible to all the objects around me, and with the mind's eye behold a courſe of action with its correſpondent ſcenery, in which I appear engaged either as a ſpectator or an actor. The conſciouſneſs of my real condition is for a time ſuſpended; and I feel pleaſure or pain, approbation or diſguſt, according to the nature of the fancied ſcene. Nor are *actions* indicatory of what paſſes within, entirely wanting; and though I may not, with the violence of Alanaſcar kicking the baſket, ſpurn the table from me, yet I ſmile, frown, move my lips, and aſſume imperfect geſtures and attitudes, in correſpondence with my internal emotions. Here, then, is a perfect illuſion effected by the mental faculties alone; commencing with complete conſciouſneſs of my real ſituation, and proceeding to as complete a forgetfulneſs of it. A perſon enters the room—and the pageant vaniſhes.

Again—I ſit in the ſame place, and take up Sterne's ſtory of Le Fevre. I am perfectly apprized, not only that Le Fevre is not in my room, but that

that no fuch perfon ever exifted. But as I read, I fuffer the writer to lead me into the fame kind of reverie which I had in the former inftance created for myfelf; and I follow him with the greater eafe, as my mind is not encumbered with the labour of invention, but paffively admits thofe reprefentations of action and difcourfe, which he has wrought into fuch an admirable refemblance of nature. I foon become fo rivetted to the book, that external objects are obliterated to me. I pity, glow, admire; my eyes are fuffufed; I fob; I am even *audible* in my expreffions of fympathy; till a meffage breaks the charm, and fummons me away, full of fhame at the real tokens remaining of emotions founded on fiction. Now will any one, fairly confulting his feelings, affert that in fuch a cafe he weeps merely from the reflexion on poffible human calamities; and that Le Fevre is not for the time a real perfon in his imagination?

Once more—I read in Tacitus the highly-wrought defcription given by that hiftorian of the return of Agrippina to Italy, after the death of Germanicus. I feel myfelf much interefted; but from the rapidity of the narration, the want of thofe minute ftrokes which are neceffary to fill up the picture of real life, and the intermixture of the author's reflexions, the whole is rather addreffed to the intellect than to the imagination; and I rather cry, "How admirably this is defcribed!" than view a diftinct fpectacle paffing before my fight. But in the midft

of

of my reading, I chance to caft my eyes upon Weft's picture of Agrippina landing at Brundufium: I fee her, with downcaft eyes, pale and extenuated, embracing the funeral urn—her little children hanging at her garment;—I fee the awe-ftruck crowd, the mourning lictors, and the hardy veterans burfting into tears. Now, indeed, the illufion is complete. I think no longer of Tacitus or Weft—my heart and my eyes obey without refiftance every call to fympathize with the widowed Agrippina. Here, then, an external object, addreffed to one of the fenfes, is called in to aid the creative power of the imagination.

Attend me next to the *theatre*. I go, it is acknowledged, with the full conviction that the place is Drury-lane, and that the actors are merely players, reprefenting a fiction for their own emolument. Nay, I go with the avowed purpofe of feeing a favourite actrefs in a particular character. The curtain draws up, and after fome preparation, enters Mrs. Siddons in Belvidera. The firft employment of my mind is to criticize her performance, and I admire the juftnefs of her action, and the unequalled expreffivenefs of her tones and looks. The play proceeds, and I am made privy to a horrid plot. With this, domeftic diftreffes are mingled, involving the two moft interefting characters in the piece. By degrees, I lofe fight of Mrs. Siddons in her proper perfon, and only view her in the affumed fhape of Belvidera. I ceafe to criticize her,

her, but give way with full foul to all the fentiments of love, tendernefs, and anxiety which fhe utters. As the cataftrophe advances, the accumulated diftrefs and anguifh lay faft hold on my heart: I fob, weep, am almoft choaked with the mixed emotions of pity, terror, and apprehenfion, and totally forget the theatre, the actors, and the audience, till, perhaps, my attention to prefent objects is recalled by the fcreams or fwooning of a neighbour ftill more affected than myfelf. Shall the cold critic now tell me, I am fure you do not *believe* Mrs. Siddons to be Belvidera, and therefore you can only be affected in confequence of "the reflexion that the "evils before you are evils to which yourfelf "may be expofed—you rather lament the pof-"fibility, than fuppofe the prefence, of mifery." The identity of Belvidera is out of the queftion; for who was Belvidera? and certainly my own liability to evils, fome of them impoffible to happen to me, and others highly improbable, is the fartheft thing from my thoughts; befides, were the effect of a fpectacle of diftrefs dependant on this principle, it would be equally requifite in the real, as in the fictitious fcene. What I feel, is *genuine fympathy*, fuch as by a law of my nature ever refults from the image of a fuffering fellow-creature, by whatfoever means fuch an image is excited. The more powerfully it is impreffed on my imagination, and the more completely it banifhes all other ideas either

either of fenfe or reflexion, the more perfect is its effect; and reality has no advantage in this refpect over fiction, as long as the temporary illufion produced by the latter continues. That fuch an *illufion* fhould take place at the theatre, where every circumftance art can invent has been employed to favour it, cannot be thought extraordinary, after it has been fhewn, that a fcene of the mind's own creation can effect it.

And for what end, but that of deception, are fuch pains taken in adjufting the fcenery, dreffes, decorations, &c. to as near a refemblance as poffible of reality? — why might not the piece be as well read in the clofet as reprefented on the ftage, if all its effect depended on the pleafing modulation of language, prompting juft reflections on life and manners? Some effect, doubtlefs, is produced by a tragedy *read*; but this is exactly in proportion to the dramatic powers of the reader, and the ftrength of imagination in the hearer; and always falls much fhort of that of a perfect reprefentation on the ftage.

But, fays the critic, "the delight of tragedy "proceeds from a confcioufnefs of fiction; if we "thought murders and treafons real, they would "pleafe no more." *Delight* is not the word by which I would chufe to denote thofe fenfations in the deeper fcenes of tragedy, which often arife to fuch a pitch of intenfity, as to be really and exquifitely painful. I do not here mean to enter into an

an enquiry concerning the fource of the intereft we take in fpectacles of terror and diftrefs. It is fufficient to obferve, that juft the fame difficulty here occurs in reality, as in fiction. Every awful and terrific fcene, from an eruption of Etna, or an attack on Gibraltar, to a ftreet-fire or a boxing-match, is gazed at by affembled multitudes. In hiftories, is it not the page of battles, " treafons and murders," on which we dwell with moft avidity? I do not hefitate to affert, that we never behold with *pleafure* in fictitious reprefentation, what we fhould not have viewed with a fimilar fenfation in real action. The truth is, that many of the tragic diftreffes are fo blended with lofty and heroic fentiments, that the impreffion of forrow for the fufferer is loft in applaufe and admiration.

When Cato groans, who does not wifh to bleed? And when this is not the cafe, but pure mifery is painted without the alleviations of glory and confcious virtue, the effects on the beholder are invariably pain and difguft. We are, indeed, by the ftrong impulfe of curiofity, led to fuch reprefentations, as the crowd are to fights and executions; but what man of nice feelings would go a fecond time to fee *Fatal Curiofity*, or the butchery of a Damien?

With refpect to the principle which renders a degree of *dramatic unity* neceffary, it feems not difficult to be afcertained. *Congruity* is alike effential in real and in fictitious fcenes to preferve a continuity

of emotion. After a pathetic fpeech in a play, if the actor immediately turns his eyes on the audience, or bows to the boxes, we feel the effect to be fpoiled; why? becaufe it is plain he is not the man he before appeared to be; for it is impoffible that poignant forrow fhould be immediately fucceeded by indifference. Thus if a perfon were to afk our charity with a lamentable tale of woe, and fuitable expreffion of countenance, and we fhould immediately afterwards detect him fmiling or nodding to a companion, the firft impreffion of pity would be loft in a conviction of fraud. A ludicrous incident on the ftage interrupts the flow of tears in the deepeft tragedy, and fills the houfe with general laughter. It is juft the fame in real life. At the funeral of a dear friend, at the death of a martyr, circumftances may occur, which not only divert the attention, but even provoke a fmile. But fuch diftractions in the real fcene are fhort, and the true ftate of things rufhes again on the mind. In imitative reprefentations, on the contrary, they may be fo forcible and frequent, as entirely to deftroy the effect intended to be produced.

Incongruities in dramatic fpectacles may be of various kinds. They may arife from the characters, the diction, or the fable. Thofe which proceed from the violation of what are termed the *unities of time and place* are, perhaps, the leaft injurious of any; for we find by experience, that the mind poffeffes the faculty of accommodating itfelf, with the

the greateſt facility to ſudden changes in theſe particulars. Indeed, where the fable will admit it, the intervention of *acts* renders the change of time and place no incongruity at all. For the drama is then a hiſtory, of which certain parts are exhibited in dialogue, and the reſt in narration. Now, it is impoſſible to give a reaſon, why the mind, which can accompany with its emotions a ſeries of entire narration, ſhould refuſe to follow a ſtory of which the moſt ſtriking parts are exhibited in a manner more peculiarly impreſſive. During the continuance, indeed, of the dramatic action, every thing ſhould be as much as poſſible in uniſon; for as the ſtage is the moſt exact imitation of real life that art can invent, and in ſome reſpects even perfect, an inconſiſtency in one point is rendered more obvious by compariſon with the reſt. Thus, with regard to *time*; as the *converſation* on the ſtage employs the very ſame ſpace of time as it would in a real ſcene, it ſeems requiſite, that the accompanying *action* ſhould not exceed thoſe limits. If, while the ſtage has been occupied by the ſame performers, or an uninterrupted ſucceſſion of new ones, the ſtory ſhould require the tranſactions of half a day to run parallel with the diſcourſe of half an hour, we could ſcarcely fail to be ſenſible of an incongruity, and cry to ourſelves, "this is impoſſible!" Such a circumſtance would give a rude ſhock to the train of our ideas, and awaken us out of that *dream* of the fancy, in which it is the great purpoſe of

dramatic reprefentations to engage us. For notwithftanding a critic of Dr. Johnfon's name (whofe heat and imagination, however, appear from numerous inftances to have been very intractable to the efforts of fiction) has thought fit to treat the fuppofed illufion of the theatre with ridicule, I cannot but be convinced of the exiftence of what I have fo often myfelf felt, and feen the effects of in others; and if the point were to be decided by authority, I might confidently repofe on that of the judicious Horace, who characterifes his *mafter* of the drama, as one,

———— qui pectus inaniter angit,
Irritat, mulcet, falfis terroribus implet
Ut magus; & modò me Thebis, modò ponit Athenis.

The notion of a temporary delufion produced by the imitative arts, and particularly by the drama, is, I obferve, fupported by Dr. Darwin, in the ingenious profe *Interludes* of his *Loves of the Plants*; and by arguments fo fimilar to thofe here made ufe of, that it will be proper for me to fay, that this fhort Effay was written fome years before the appearance of that beautiful poem. The writer whom Dr. Darwin combats on this occafion, is Sir Jofhua Reynolds, who feems implicitly to have adopted the opinion of his friend Dr. Johnfon.

J. AIKIN.

On the USES *of* CLASSICAL LEARNING, *by* G. GREGORY, *D. D. Domeſtic Chaplain to the Lord Biſhop of Landaff. Addreſſed to* DR. PERCIVAL.

Read Nov. 4.

DEAR SIR,

IN all human purſuits, if we would form a juſt eſtimate of their value, a cloſe and methodical examination of their uſes and advantages is abſolutely neceſſary. A man may read and write whole volumes of declamation, and yet not underſtand the ſubject, which has apparently occupied his thoughts. Without complimenting indeed unreaſonably the age in which we live, (for in ſome inſtances it appears to have been extravagantly complimented) this, I apprehend, may at leaſt be advanced with truth and modeſty: that a more logical and leſs confuſed method of inveſtigating truth, has been adopted of late years; ſenſeleſs definitions, at firſt introduced by the ſchool of Ariſtotle, are generally laid aſide, and facts are appealed to with confidence, as the only baſis of ſolid argument.

There are no ſubjects more univerſally intereſting to mankind, than thoſe which are connected with the education of youth; and I ſhould humbly conceive that which I have choſen for the preſent Eſſay, not entirely unworthy the attention of your moſt reſpectable and eminently uſeful Society.

Without

Without wishing to disparage the pursuits of others; without presuming even to smile at the minute philosopher, whose life is consumed in contemplating and exploring the varied plumage of the butterfly, or who felicitates himself as the first of citizens, for having added a non-descript to the unbounded catalogue of mopes; without weighing the important consequences which are to result to the nation, from the fortunate discovery of a curious grave-stone, without promising our admiration to the voluminous disquisitions, with which certain laborious authors may chuse to entertain the public, on the tasteless variety of a tessellated pavement, or the shapeless fragment of some homely utensil; let it be our present business to explore the tracts of mind, to measure and calculate the value and utility of the noblest productions of human genius, and to view the growth and extension of reason and truth.

The study of ancient lauguages, the Greek and Latin at least, and of what are usually termed the classical authors in those languages, has, for some centuries, constituted a branch of liberal education, in every refined nation in this quarter of the globe. It appears, indeed, no more than a just tribute to the labours of antiquity, that posterity should not ungratefully consign them to unmerited oblivion; nor even content itself with contemplating that imperfect copy of their features, which a translation exhibits. It is a curiosity natural to the human mind, a becoming pride, to wish as intimate an acquaintance

acquaintance as poſſible with the illuſtrious dead; to hold, as it were, a friendly converſation with them, in their own language, and in their own peculiar ſtyle.

If theſe, however, were the only reaſons for the cultivation of Claſſical Literature, though they might intereſt the philoſopher, and the man of taſte, ſtill we could not in juſtice allow them that univerſal cogency, which is neceſſary to ſanction a general Practice. There muſt be other motives to warrant the hardſhip, which is impoſed on almoſt every well-born youth, of conſuming in ſevere ſtudy, ſeveral of the moſt gay and delightful years of life, and of encountering hardſhips, which nothing but an object of ſome importance can juſtify.

Without wiſhing to appear a lover of paradox, permit me, dear Sir, to ſtate that I do not in my own mind allow much force to the maxim which inſiſts on the abſolute neceſſity of claſſical learning in what are called the Profeſſions. I confeſs, I think it a moſt pernicious pedantry which would involve in any kind of myſtery, thoſe ſciences which are moſt eſſential to human happineſs. The Chriſtian world has been no gainer either as to piety or morals by ſpeculative divinity; all that is neceſſary to mankind in theology ought to be, and I doubt not is, plain and eaſy to be comprehended by every capacity.—What! ſhall none but Greek and Latin ſcholars be permitted to make uſe of their reaſon on the moſt neceſſary topics? Admitting that there ought

ought to be men in the christian church who should be able to read the holy scriptures in their original languages, to correct mistranslations, to compare and collate manuscripts, and to detect errors of every kind; must every plain country clergyman be an adept in languages, which cannot afford him the least assistance in instructing and informing the poor and illiterate flock, which is committed to his care? —He cannot preach in Latin; the plainest and least pedantic stile is that which will be most beneficial to his hearers; nay the rust of college manners, or the unyielding spirit of literary arrogance, are perhaps qualities, more directly than others, calculated to obstruct or to frustrate his pious labours.

In medicine, you, Sir, are I am sure too liberal not to see that the use of a dead language has certainly impeded, rather than advanced science. Who will pretend to alledge that the modern practitioner is obliged to have recourse to the ancients for the principles of his art? The English language, if we include the translations from foreign authors, contains a body of medicine, ample and voluminous enough to engage the attention of most practitioners, and to furnish them with every practical kind of information. Would it not really be better for mankind, would it not prevent the most fatal mistakes, if prescriptions were written in our own language, instead of those uncouth characters, which frequently appear like hieroglyphics, and are too often absolutely so to those who are to prepare the medicine? In

short

fhort, ought not a fcience which concerns the firft of temporal poffeffions, to be laid as open as poffible to the reafon of mankind?—Ought it not to be induftrioufly weeded of all technical jargon?—Ought not every thinking perfon to be invited, as it were, to pay fome attention to the progrefs of thofe difeafes, which he may have an opportunity of obferving, and to bring in with confidence, be they right or wrong, his quota of difcoveries to the common ftock? I do not believe fuch a circumftance would be injurious to the health of the community, or difcouraging to the regular practitioner.—It is only by knowing a little of the outlines of medicine, that any perfon can eftimate truly the value of a phyfician, or fee the neceffity of long inftruction and much practice, to accomplifh a man in this important art. Is it not the ignorance of the public on thefe points, that gives countenance to quackery, and is it not, becaufe the fcience is treated as a kind of myftery, that every antiquated female is poffeffed of fome infallible noftrum? In other arts or profeffions, the knowledge of Latin is not infifted on as a neceffary qualification, and yet no perfon, not regularly brought up to them, prefumes to intrude himfelf into thefe profeffions. In a word, let no man practice phyfic, who fhall not be regularly educated or inftructed in it; but in the name of reafon, what has the writing or fpeaking of Latin to do with the cure of difeafes?

I grant that some useful treatises in medicine are occasionally published in Latin, but these are few, and the argument will equally apply to the necessity of accomplishing the young physician, in all the European languages. In a word, let it be remembered, that I am not pleading against the utility of the dead languages, but in favour of their *general* utility, against the vulgar notion that they are only necessary to certain professions.

Of all branches of knowledge, the *Law* ought to be the plainest, and most easily understood. Praying in an unknown tongue is not half so great a solecism, as the involving in mystery and obscurity those rules, which are to govern the conduct of every individual citizen. How can I be expected to conform to laws, with which I am to be unacquainted, or which I cannot understand?—What indeed are the evils to which the inhabitants of this country are not exposed, on account of the complex and intricate nature of our laws? I must observe (and I do it with no intentional disrespect to the honourable and upright part of the profession) that all who are unfortunate enough to hold their property by any disputable title, or who have rashly exposed themselves in any way to the mischiefs of legal chicanery, are made the prey of one class of citizens; and it is almost proverbial, that of all English commodities, Justice is by far the most expensive. If any part of what I have urged on this topic, be consistent with fact, ought a classical education to be considered as a *necessary* qualification

qualification for underftanding what all ought to underftand?—No, Sir, the ufes of claffical learning are not partial but general, and not confined to a particular profeffion.

It muft be confeffed, that with refpect to the cultivation of the dead languages, fociety is at prefent in a very different ftate from what it was at the revival of Letters. At that period, all the fcience, all the hiftory, all the tafte which exifted, were locked up in the volumes of the Ancients; there was no accefs to any branch of knowledge but by this path; it was neceffary to be introduced to this enlightened fchool, or to remain in barbarifm and ignorance.

In the prefent ftate of literature it would be difingenuous to deny, that it is poffible for a perfon, not claffically educated, to make a proficiency in almoft any department of fcience or literature.

In medicine and philofophy fome perfons might be named, of no inconfiderable eminence, with but a very flender portion of Greek or Latin. In law and politics alfo fome inftances might be adduced, were not a falfe pride unfortunately predominant, which might conftrue into an affront, what is really a compliment. The ladies may be cited with lefs ceremony on this occafion. In hiftory and philofophy we have a Macaulay; in poetry a Seward and a Williams; in morals a Burney; in dramatic writing a Cowley and an Inchbald, all unacquainted with the languages and compofitions of the ancients. It does not, however, follow, from thefe fplendid examples,

 that

that the ſhorteſt and eaſieſt way to knowledge and excellence, is through the medium of our mother tongue, and that a claſſical education is of no utility whatever. One leſſon indeed we may deduce from what has been advanced on this topic, and that is, to look with a leſs faſtidious eye upon thoſe, who without theſe advantages (for advantages they certainly are) have made good their progreſs to eminence and fame.

In eſtimating the uſes of a claſſical education, it is neceſſary to confine our views entirely to the *preſent ſtate* of literature, for indubitably a few centuries ago its advantages were infinitely greater, it was indeed not ornamental, but eſſential to ſcience. Diſcarding, therefore, as much as poſſible, every prejudice of every kind, the real uſes of a claſſical education appear to be nearly as follow.

I. In the firſt place, grammar, and perhaps orthography, are aſſiſted, by an early acquaintance with the dead languages. I would not be underſtood to aſſert, that a perſon may not be practically verſed in both theſe branches, without any ſuch aſſiſtance, but it is a queſtion, whether almoſt an equal portion of time is not conſumed in the attainment of them, through the ordinary medium of Engliſh grammars, &c. Beſides this, I am apprehenſive that a complete, an enlarged, a ſcientific acquaintance with the principles of grammar, is hardly to be obtained, without the knowledge of ſome other language than our own. The grammar of the Latin language is more

regular

regular than that of any other, and it is therefore admirably calculated to initiate young perſons in that neceſſary ſcience.

II. A ſimilar advantage, which flows from a claſſical education, is a general knowledge of the ſtructure of language. The Greek, ſo copious, ſo curiouſly compounded, ſo admirably adapted to ſupply every want of the mind with reſpect to expreſſion, affords the happieſt inſtance of art and human invention in the conſtruction of language; it is impoſſible to ſtudy it without perceiving our ideas enlarged and improved on this curious ſubject. Such an acquaintance with the ancient forms of language, enables us to improve our own, to extend and diverſify our modes of expreſſion, to add new and proper words, if neceſſary; and gives us confidence in occaſionally introducing new expreſſions, and deviating from the common and colloquial forms.

III. A third uſe, which is not leſs obvious, reſults from an accurate acquaintance with the etymology of words. To the phraſes of common life, cuſtom has ſufficiently familiarized us, and theſe indeed are moſt of them derived from our northern anceſtors. But the language of ſcience, the language of books indeed, in general, is of claſſical origin; and it is impoſſible to know the full force, the correct application of words, without, in ſome degree, being acquainted with their ſource.

Every man who has compoſed for the public, muſt be ſenſible of this obſervation; and allowing every thing

thing to genius and induftry, ftill it cannot be denied that accuracy in writing, at leaft, is almoft exclufively the characteriftic of thofe, who can boaft fome acquaintance with the languages of antiquity.

IV. It is fome commendation of almoft any purfuit, to fay, that it affords us an elegant and an innocent amufement. That it engages occafionally the mind, which, perhaps, would otherwife be the prey of fpleen; that it fills up agreeably thofe hours, which, if left vacant, might perhaps be contaminated with vice:

> - Ni
> Pofces anté diem librum cum lumine; fi non
> Intendes animum ftudiis & Rebus honeftis,
> Invidia vel amore vigil torquebere.

It is true there are a number of excellent authors in our own language, but ftill the perufal of the claffics, in their original drefs, varies and extends this fpecies of entertainment.

V. It is pleafant to obferve the manner of an original author, and inftructive to remark the peculiar ftyle, in which men of exalted genius have, at fuch diftant periods, expreffed themfelves.

VI. Have you ever remarked, Sir, that from the perufal of an original author, one feems to form a more perfect picture of the manners and characters of the age which he defcribes, than can be acquired by a tranflation? I think Homer is a ftriking illuftration of this fact; indeed, one of the great ufes of the Iliad, has always appeared to me, to be the

the light which it reflects on the hiſtory of mankind, in the early periods of ſociety.

VII. Whoever expects to find in the ancients the perfection of ſcience, will be diſappointed; but this will not warrant us in a total rejection of all the aſſiſtance which may be derived from this ſource. Of natural knowledge, in particular, there is certainly but little to be collected from their writings. Ariſtotle, in his hiſtory of animals, is a laborious and tolerably correct reporter of facts—but how ſmall a branch of natural ſcience is this, and how much better detailed by modern writers? Pliny, except where he has copied Ariſtotle, is a wretched fabuliſt, and no reaſoner at all.

The metaphyſics of Plato are ſubtil, viſionary, and uſeleſs; thoſe of Ariſtotle are mere ſcholaſtic definitions. In the republic of the latter, as well as in ſome of the writings of Xenophon and Cicero, are ſome good political obſervations; but the experience of the moderns, has enabled them greatly to improve this important ſcience.

But if the ancients were deficient in theſe topics, they were not ſo in what may be conſidered as the baſis of uſeful knowledge, in morals, and an extenſive acquaintance with the human heart. Though I confeſs I do not find much of ethical ſcience in Plato, which is deſerving of attention; yet in the Απολλωγια of Socrates, and ſome other of the dialogues, there occur ſome beautiful reflections. The morals of Ariſtotle are a dry common place book,

chiefly

chiefly conſiſting, like the reſt of his philoſophy, in definitions. In the writings of the ſtoics, however, ſome admirable precepts are to be found—indeed we may go further; we may venture to ſay, there is ſomething of principle in the doctrines of theſe philoſophers; they mould ethics into a kind of ſcience, and diſtinguiſh with accuracy the different ſtages of human perfection.

> Απαιδευτȣ εργον, το αλλοις εγκαλειν, εφ' ὁις αυτος πρασσει κακως. ηργμενȣ παιδευεσθαι, το ἑαυτῳ. πεπαιδευμενȣ, το μητ' αλλῳ, μηθ' ἑαυτῳ.
>
> Epict. Enchirid. c. 10.

> Ιδιωτȣ ςασις και χαρακτηρ· ȣδεποτε εξ ἑαυτȣ προσδοκαν ωφελειαν η βλαβην, αλλ' απο των εξω. Φιλοσοφȣ ςασις και χαρακτηρ· πασαν ωφελειαν και βλαβην, εξ ἑαυτȣ προσδοκαν.
>
> Ib. c. 71.

Without the rage for definition ſo obvious in Ariſtotle, their diſtinctions were happier, more accurate, and more agreeable to nature.

> Ουτοι δε ὁι λογοι ασυνακτοι. εγω σȣ πλȣσιωτερος ειμι, εγω σȣ αρα κρεισσων. εγω σȣ λογιωτερος, εγω σȣ αρα κρεισσων. εκεινοι δε μαλλον συνακτοι· εγω σȣ πλȣσιωτερος ειμι, ἡ εμη αρα κτησις της σης κρεισσων. εγω λογιωτερος, ἡ εμη αρα λεξις της σης κρεισσων. συ δε γε ȣτε κτησις ει, ȣτε λεξις.
>
> Epict. Enchir. c. 66.

These

These ideas are differently, and perhaps, still more sublimely expressed by Antoninus.

θανατος δε γε και ζωη, δοξα και ἀδοξια, πονος και ἡδονη, πλουτος και πενια, παντα ἐπισης συμβαινη ἀνθρωπων τοις τε ἀγαθοις και τοις κακοις, ὀυτε καλα ὀντα, ὀυτε αἰσχρα.

Anton. Lib. II. c. 11.

Του ἀνθρωπινου βιου ὁ μεν χρονος, στιγμη· ἡ δε ὀυσια, ῥεουσα· ἡ δε αισθησις, ἀμυδρα. ἡ δε ὁλου του σωματος συγκρισις, ἐυσηπτος· ἡ δε ψυχη ῥομβος· ἡ δε τυχη, δυστεκμαρτον· ἡ δε Φημη ἀκριτον, Συνελοντι δε ἐιπειν, παντα τα μεν του σωματος, ποταμος· τα δε της ψυχης, ὀνειρος και τυφος. ὁ δε βιος, πολεμος και ξενου ἐπιδημια· ἡ ὑστεροφημια δε, ληθη. τι ὀυν το παραπεμψαι δυναμενον; ἑν και μονον, Φιλοσοφια. Τουτο δε, ἐν τῳ τηρειν τον ἐνδον δαιμονα ἀνυβριστον, και ἀσινη, ἡδονων και πονων κρεισσονα, μηδεν ἐικη ποιουντα, μηδε διεψευσμενως και μεθ᾽ ὑποκρισεως, ἀνενδεη του ἀλλον ποιησαι τι, ἡ μη ποιησαι.

Ib. L. ii. c. 17.

ὀυδαμου γαρ ὀυτε ἡσυχιωτερον, ὀυτε ἀπραγμονεστερον ἀνθρωπος ἀναχωρει, ἡ ἐις την ἑαυτου ψυχην· μαλισθ᾽ ὁστις ἐχει ἐνδον τοιαυτα, ἐις ἁ ἐγκυψας ἐν πασῃ ἐυμαρεια ἐυθυς γινεται.

Ib. L. iv. c. 3.

Nor is there wanting a higher philosophy for a basis to these reflexions: speaking of death:

Το δε ἐξ ἀνθρωπων ἀπελθειν, ἐι μεν θεοι ἐισιν, ὀυδεν δεινον· κακῳ γαρ σε ὀυκ ἀν περιβαλοιεν· ἡ δε ἐι τι ὀυκ ἐισιν,

ἡ ȣ̓ μελει ἀὐτοις των ἀνθρωπειων, τι μοι ζην ἐν κοσμῳ κενῳ θεων, ἢ προνοιας κενῳ; ἀλλα και ἐισι, και μελει ἀὐτοις των ἀνθρωπειων.

Anton. Lib. ii. c. 11.

Τα των θεων προνοιας μεςα. τα της τυχης ȣ̓κ ἀνευ Φυσεως, ἢ Συγκλωσεως, και ἐπιπλοκης των προνοια διοικȣμενων.

Ib. c. 3.

It must, however, be confessed of the Stoic morality, that much of it is extravagant, and some of it trifling; that it is built upon too few principles, abounds with repetition, and, perhaps, justly incurs the censure of (I think) Lactantius; that it was calculated for actors on a theatre, and not for men in the world.

The most regular and methodical tract upon ethics, which is contained in the whole scope of classical literature, is the offices of Tully; this valuable fragment contains much excellent reasoning, and much sound observation—but, still it appears to me but a fragment. Whether the lively and desultory genius of Cicero, revolted against the toil of a laboured, methodical, scientific production, or whether he was interrupted in the progress of his task, the work is certainly imperfect; there are several useful topics entirely omitted, and even the system itself is left in an unfinished state.

In the other beautiful rhapsodies of Tully, in vain shall we look for any thing like system or method.

method. No man, however, can read his Cato Major, his De Amicitia, his Tuſculan Diſputations, without moral improvement; his letters, and all his writings, abound in animating and intereſting reflexions, in excellent maxims. There is a point, a force, a climax too in his obſervations, which cannot be too greatly admired, and carries the mind along with it, and which gives a novelty even to what is common place in itſelf:

"Et nomen pacis dulce eſt, & ipſa res ſalutaris; ſed inter pacem & ſervitutem plurimum intereſt: Pax eſt tranquilla libertas, ſervitus poſtremum malorum omnium, non modò bello, ſed morte etiam repellendum."

Cic. in M. Ant.

"Sin aliquando neceſſitas nos ad ea detruſerit, quæ noſtri ingenii non erunt: omnis adhibenda erit cura, meditatio, diligentia, ut ea ſi non decorè at quam minimum indecorè facere poſſimus."

Cic. de Off.

In the writings of the Poets, the moſt uſeful and beautiful reflexions are expreſſed with a ſimplicity which delights, or a force which penetrates the heart; the former is chiefly the characteriſtic of the Greek, the latter of the Roman Muſe:

ΕΦ' ῃ συ μαινῃ· Κεινο καλλιςον, Τεκνον,
Ισοῖηῖα τιμᾳν, ἢ Φιλȣς ἀει Φιλοις,

 Πολεις

Πολεις τε πολεσι, ξυμμαχους τε ξυμμαχοις
Συνδει. το γαρ ἰσον, νομιμον ἀνθρωποις ἐφυ.
Τῳ πλεονι δ' ἀιει πολεμιον καθιςαται
Τουλασσον, ἐχθρας θ' ἡμερας καταρχεται.
Και γαρ μετρ' ἀνθρωποισι και μερη ςαθμων,
Ισοτης ἐταξε, κἀριθμον διωρισε.
Νυκτος τ' ἀφεγγες βλεφαρον, ἡλιου τε φως,
Ισον βαδιζει τον ἐνιαυσιον κυκλον·
Κοὐδετερον αὐτοιν φθονον ἐχει νικωμενον.
Ειθ' ἡλιος μεν, νυξ τε δουλευει βροτοις.

Euriss. Phœniss. 548.

Ονομα γαρ, ἐργον δ' οὐκ ἐχουσιν οἱ φιλοι,
Οἱ μη 'πι ταισι συμφοραις ὀντες φιλοι.

Id. Orest. 455.

The animated and rational morality of Horace, cannot be too closely studied—What a fund of fine observation, and judicious admonition, is contained in his satires?—With what grace and vivacity does he recommend the practice of virtue, and the cultivation of knowledge, in his elegant epistles? The satires of Juvenal and Persius, not only present us with excellent pictures of local manners, but with much general and useful instruction—But I feel, that what would be information to the unlearned, is trite and common-place to the learned society, which, through your medium, I am addressing—I therefore stop my pen, admonished, also, by the ordinary limits of a literary memoir.

If

If HISTORY be classed among the sciences, in this the ancients cannot be too warmly commended. To their admirable writings we are indebted, not only for the most important facts in the history of mankind, but for the most perfect models in that species of composition. I think, Sir, the ancients have not been equalled in this line, and I think I can venture to say, that I have not seen the sweet simplicity of Herodotus—the dignity of Thucydides, the harmony and elegance of Sallust, or the pointed and forcible expression of Tacitus, transferred into any modern language, by their most learned translators.

VIII. But whatever was wanting to the ancients, in science, is amply compensated in taste. Homer and Virgil are, I think, still unrivalled, and the latter of them is certainly still untranslated.—The pastorals of Theocritus, and perhaps the odes of Pindar, are without parallels in modern languages—The satires of Horace and Juvenal have only been imitated.—In every department of prose composition also, we find among the ancients the most perfect models. The clear and energetic reasoning of Demosthenes, the full, harmonious, and ornamental periods of Cicero, and the sententious neatness of Sallust, have never been excelled. To form, therefore, a correct taste, the easiest and most effectual mode, is certainly by a well directed study of these inestimable compositions, and by occasionally comparing them with the excellencies and defects of modern productions.

If in any department of polite literature, which they have cultivated, the ancients have failed, it is in the drama; whether owing to the defects of their theatres, which admitted no change of ſcene, or whether we are to conſider the drama, as one of the moſt improveable branches of literature, and as then being only in its infancy, I muſt confeſs to you, my dear Sir, that there are ſcarcely any productions, which I find ſo unintereſting, as the Greek tragedies. The uniformity, the nothingneſs of their plots, their tedious declamations, and their ſnip-ſnap dialogue, are poorly compenſated for, by a few elegant odes, and a few beautiful or ſtriking ſentiments. If one play of Terence (the Andria) only had been left to poſterity, he would rank among the firſt of dramatic writers, but after reading this, who can admire any other of his productions? Ariſtophanes and Plautus are as much beneath our common farce writers, as the beſt of the ancient dramatiſts are inferior in excellence to Shakeſpear and Moliere.

There are ſome other branches of literature, in which I think the moderns have excelled, and ſome which have not at all been cultivated by the ancients; but this does not, in any view, militate againſt the utility of claſſical literature, as an accompliſhed perſon ought to be acquainted with the moſt perfect productions, both of ancient and modern times.

From a fair conſideration of the real uſes of claſſical literature, ſome practical concluſions reſult, which appear

appear of no inconſiderable importance in the education of youth.

Impreſſed as I am, with a full ſenſe of the advantages reſulting from a claſſical education, I cannot help thinking, that an unreaſonable and enthuſiaſtic regard has ſometimes been paid to the writings of the ancients. Inſtead of conſidering them as uſeful aſſiſtants, as guides to knowledge, they have been extolled, as containing within themſelves, all that is worthy of being known, and men have miſtaken the rudiments of ſcience, for ſcience itſelf. How many have devoted their lives to the ſtudy of the claſſics, as if there were no other duties to be performed, no other advantages to be obtained, no other laurels to be reaped? How many have continued, during their exiſtence, in the elements of ſcience, without extending their views to any thing beyond them, without indeed making uſe of their own underſtanding.

I ſhould wiſh to ſee the ancients ſtudied for their matter, as well as for their language—But the information which they convey, is too commonly made a ſecondary conſideration. The attention of youth is directed to the elegant latinity of Cæſar and of Horace, not to the facts, obſervations, or precepts, which are contained in theſe valuable authors. If the tutors of our youth, condeſcend to remark even upon the beauties of the claſſics, it is not on the beauty of ſentiment, it is not on the beauty or vigour of imagination, it is not on the poetical ornaments.

ornaments.—Their attention is at the utmoſt extended to a choice of words, to a curious grammatical connexion, or to the nice intricacies of idiomatical phraſeology.

At the revival of letters a race of commentators were uſeful, if not neceſſary; they were the pioneers of literature, who cleared the way for more reſpectable adventurers. But in the preſent ſtate of literature, can we behold without regret a man of genius dedicating a life to a few barren and fruitleſs verbal Criticiſms, to the regulating of a few phraſes, or correcting in a few inſtances the quantity and metre of an obſcure Author; when, had he applied his talents as they ought to have been applied, he, perhaps, would have produced an original compoſition, more valuable than the production on which he has ſo unworthily beſtowed his labour?

To write Latin decently and intelligibly, may occaſionally prove a convenience to a literary man; chiefly in facilitating his commerce with foreign literati; but ſurely the attempt (for it is but an attempt) to compoſe poetical productions in Greek and Latin, is, at beſt, only a ſpecies of elegant trifling. If life be ſhort, and ſcience of unbounded extent; if our duties be many, and but few our opportunities of qualifying for them, and performing them as we ought, are we juſtified in neglecting ſolid and uſeful branches of knowledge; are we to purſue ſtraws, and leaves, and Goſſimer, while we leave

leave the grain and fruits, which should be the support of life, to perish and to rot?

The example of some of our enlightened neighbours on the continent, may, perhaps, be worthy our imitation. They study the ancients, but they study them to read and imitate them. They are not devoted to this study alone; they make themselves masters not only of the ancient, but of the modern languages; they can converse with the well informed of other nations, and they can read their works. Thus an infinite extent of knowledge is opened to their view; and they are less likely to be the slaves of prejudice than the cloistered pedant, who expects to find the whole of knowledge in the blind reveries of ancient scholiasts—whose philosophy is locked up in Plato, whose morals and politics are only derived from Aristotle, and who regard the tales of Pliny, as the perfection of natural science.

It is by estimating truly the advantages of classical learning, and not by over-rating its importance, that we can give it respect, or promote its cultivation.

I think an acquaintance with the ancient languages, essential to the formation of an accomplished character; but if a man would be accomplished he must not stop there—he must not expect to find in the ancients what they do not contain; or "see in Homer, more than Homer knew."

Were I to chuse a preceptor for my own children, I should certainly prefer a man of general knowledge. A man who was conversant with modern literature and modern science, as well as with the ancient writers, would certainly improve the taste, would certainly enlarge the understanding of young persons, more than the mere Classic, even though the latter should make Latin verses with greater facility.

In a word, without neglecting the ancients, we may derive much wisdom, much taste, and much pleasure from the productions of modern writers; the study of both is compatible, if we study both as we ought.

I owe many apologies, Sir, to your respectable Society, for the unfinished and imperfect state in which this Essay is presented. You were pleased to call upon me for some contribution to your valuable fund of literary and philosophical information, and I was unwilling to raise your expectations by delay. In the midst of a laborious life, and a series of interruptions, I have snatched a few moments to arrange my ideas on a subject, which I should wish to see taken up by some abler hand, but which appeared of too much importance to be utterly neglected.

I am, dear Sir,

With much respect,

Your most faithful servant,

G. GREGORY.

Winkworth Buildings,
April 9th, 1791.

A Diſſertation upon the Ancient Carved Stone Monuments *in* Scotland, *with a particular Account of one in Dumfriesſhire, by* Robert Riddell, *of Glenriddell, Eſq. Captain of an Independent Company of Foot, F. A. S. and Member of the Literary and Philoſophical Society of Mancheſter.* *Read Dec.* 2, 1791.

THERE is not perhaps a more univerſal feature in the hiſtory of man, from the moſt early dawn of hiſtorical information to the preſent advanced period, than that every nation before the introduction of letters, made uſe of Hieroglyphical ſymbols to communicate to their poſterity their diſcoveries in the arts and ſciences, the fundamental principles of their religion and laws, and the moſt celebrated exploits of their princes and heroes.

In Egypt we find many monuments remaining covered with hieroglyphic ſymbols, the art of deciphering which was entirely loſt in the time of Herodotus, the hiſtorian; and when Hernando Cortes conquered Mexico, the moſt civilized of any American nation, we find they then tranſmitted their annals to poſterity by hieroglyphical and ſymbolical paintings.

In Scotland, particularly along the Eaſt, many hieroglyphic Monuments are ſtill to be met with.

Mr. Gordon, in his Itinerarium Septentrionale— Mr. Pennant, in his Tour in Scotland, and the Rev. Mr. Cordiner, have given to the world prints, accompanied with defcriptions of many of thefe monuments, in their refpective elegant and ufeful publications. Captain Grofe and Mr. de Cardonnel have it in their power to add confiderably to thefe monuments already publifhed.

They appear to have been the work of the Scotch Norwegians and Danes, perhaps from the ninth and tenth centuries to the time of David Ift. when the general ufe of letters over all Scotland, rendered laboured fculptures of this kind unneceffary. Several of them bear undoubted marks of their being erected by Chriftians—others I believe to have been the work of Pagans.

In Dumfries-fhire are the remains of fome of thefe very ancient Monuments. The one in Ruthwell church-yard has been publifhed by the Antiquarian Society of London, with very great accuracy and elegance, from a drawing of Adam de Cardonnel, Efq. and the one I mean to defcribe has been delineated with the utmoft fidelity by the accurate pencil of my learned friend Francis Grofe, Efq. F. A. S.

This very ancient obelifk ftands upon the banks of the river Nith, near the village of Thornhill, in Nithfdale, a diftrict of the fhire of Dumfries— Mr. Maitland is the only Scottifh hiftorian I can

at

at prefent recollect, who has taken notice of it, and he does it very flightly.

All tradition refpecting it is loft; fo that the date of its antiquity can be conjectured only by comparing it with thofe publifhed in the before-mentioned works. It is a ftone about fourteen feet in height, with a pedeftal, or focket, into which it is funk, rudely hewn into two fteps. At the bottom where it rifes from the pedeftal, it is two feet in breadth, tapering at the top to twelve inches. The fides or edges at the bottom are about fix inches, tapering at the top to four.

The one fide has five diftinct co-partments, befides a fpace at the top, wholly defaced. The oppofite fide appears to confift of two co-partments, and is much more defaced than the other. The fides or edges are carved in an elegant kind of chain pattern. Upon the two fides are figures of animals, the bodies of which are formed into unnatural and grotefque fhapes, but the annexed drawing will convey a better idea of this Monument than it is poffible to defcribe in words.

A gentleman from Rofs-fhire informed me, that in the ifland of Lewis, there ftill ftands a very entire and highly ornamented Stone pillar, not much inferior to the one near Horres, either in point of fize or carving. The remarkable circumftance attending this Obelifk is, that it ftands on a fmall hill in the midft of an almoft inacceffible bog, fome miles from the fea. It is the general opi-

nion

nion that it muſt have been brought to the iſland, as there is no ſtone to be ſeen in Lewis of the ſame kind as this Obeliſk. I have made applications to different gentlemen in the neighbourhood to procure a drawing of this ſtone pillar, but have not as yet been able to procure one.

I have often thought that were drawings of all thoſe carved Monuments in Great Britain and Ireland collected into one work, they might then be claſſed by an Antiquary, well verſed in the Runic, Celtic, and ancient Iriſh characters; and then perhaps, it might with certainty be determined whether they were intended to mark the ſepulchres of heroes—the fields of battles—or to record hiſtorical events, or religious ceremonies.

OBSERVATIONS

OBSERVATIONS *on* ALPHABETICAL CHARACTERS; *and particularly on the* ENGLISH ALPHABET: *with an Attempt to ſhew its Inſufficiency to expreſs, with due Preciſion, the Variety of Sounds, which enrich the Language.* — *By Mr.* SAMUEL HARVEY.

(Read by the Author March 23, 1792.)

AN CUJUSLIBET AURIS EST EXIGERE LITERARUM SONUS? NON, HERCULE, MAGIS QUAM NERVORUM.

Quinctill. Inſtit.

SECTION I.

SO much has been already written, in commendation of the Engliſh Language, that it would be ſuperfluous in this place to add any thing to the eulogies which have been, from time to time, beſtowed thereon: and indeed ſo numerous are the ſources, whence, as from various treaſuries, it has derived its riches; and ſo many and excellent thoſe authors, who, for more than a century paſt, have, by their writings, been ſuperadding dignity and reputation thereto, that its ſuperiority, above many languages which might aſſert a much higher antiquity, has been for ſome time acknowledged, by thoſe whom we ought not to ſuppoſe actuated by partiality;

tiality; by Foreigners of diſtinguiſhed abilities, well verſed in the works of eminent Engliſh authors, and who themſelves were ſuch maſters of the language, as to write it with elegance and eaſe; and poſſeſſing, withal, ſuch an acquaintance with other languages as enabled them, by compariſon, to become the moſt accurate arbiters of the worth of each. A very flattering character of our language is given by Mr. Barretti,* in the preface to the ſecond

* It can hardly be neceſſary to remark what is ſo well known—that this ingenious writer was formerly Secretary, for foreign correſpondence, to the Royal ~~Society~~ Academy; and one of the intimate friends of Dr. Johnson, &c. And he frankly obſerves that (before he was acquainted with England) conceiving, that after a knowledge of Greek and Latin, nothing further but French could be neceſſary to form the *ne plus ultra* of every well-bred gentleman, he applied himſelf to acquire it; and having read the works of Montagne, Paſcale, Malbranche, Corneille, Moliere, la Fontaine, &c. imagined that there was not any thing which could poſſibly come in competition therewith: "ma molto piacevolmente," ſays he, "m'aveddi eſſermi ingannato a partito allora che mi trovai mediocremente maeſtro del Britannico parlare. Oh quante belle e grandi coſe Paeſani mici, ho lette in queſti libri che non ſi leggono in quelli d'altre genti! Paſſerò in ſilenzio un Hooker, uno Scot, un Clarke, un Bentley, uno Stillingfleet, un Tillotſon, e centinaja d'altri loro teologi e ſacri oratori che valoroſamente battagliando contra i numeroſi ſcredenti del loro e d'altri paeſi, hanno in mille modi e poco meno che con geometrica evidenza provata la verità della religione rivelata, cosí che hanno coſtretti gli Ateiſti e i Deiſti a rifugirſi negli ſterili deſerti dell' ignoranza, o a naſconderſi nelle

ſecond volume of his Italian Dictionary; and, with ſuch a character, it is a pity that it ſhould have any faults; yet ſome it has, and will probably long retain, as excreſcencies too nearly attached and too long growing with it to admit of being removed, without ſome difficulty. Here I more particularly allude to its S Alphabet,

caliginoſe cave della mentecattagine. Non dirò verbo de' loro filoſofi e cercatori diligentiſſimi della natura, come a dire un Bacono, un Boyle, un Newton, e tant' altri ſcrutinatori dell' uomo e dell' altr' opere della mano onnipotenti. Laſcerò indietro i loro tanti moraliſti, i loro politici, gl' iſtorici e cronologiſti loro, i meccanici numeroſiſſimi, e farò ſolamente alcune poche parole de' loro poeti, perchè *queſto è l'umore dove io pecco*, per ſervirmi d'un modo di dire del noſtro Berni. Quanto carta però non mi converrebbe ſcarabocchiare per darvi ſolo una malabbozzata idea d'uno Shakeſpeare, d'uno Spencer, d'un Milton, d'un Dryden, e di molt' altri divini ſpiriti, che accozando chi più chi meno alla ſchiettezza della poeſia Greca, la venuſtà de' Latini, la vaghezza degl' Italiani, e la nitidezza de' Franceſi con la robuſtezza e fantaſticagine della Saſſonia e delle Gaule hanno prodotta una maniera di penſar poetico, della quale noi ſucceſſori del Lazio e imitatori di quegli antichi dell' Acaja non ci curiamo ancora quanto dovremmo fare, contentandoci troppo manſuetamente che i noſtri Poeti abbiano con iſcrupoloſa induſtria modellati i penſieri loro e il loro modo di poetare ſugli eſemplari Greci e Latini.*

* After what better models could they have formed their thoughts? The advice of Horace ought certainly to have ſome weight;

Vos exemplaria Græca
Nocturnâ verſate manu, verſate diurnâ,

Alphabet, in reſpect to marking that variety of ſounds, in which it is certainly richer, as I ſhall by and by attempt to prove, than many of the modern languages; though as to characters for expreſſing thoſe ſounds with due exactneſs, there are undoubtedly few languages ſo deficient.

It is not my intention, however, to write an eſſay upon the general conſtruction of the language; neither ſhall I here endeavour to recapitulate all the various conjectures, which have been written, relative to the invention of alphabetical characters; nor ſhall I dwell upon the hiſtory of their improvement, progreſs, and diverſity; as theſe are circumſtances, wherewith almoſt every one is well acquainted: But I ſhall confine this paper chiefly to ſome obſervations, on the variety of ſounds in the Engliſh language, and the impoſſibility of a diſtinct and rational notation thereof by our preſent alphabet, perverted as it too often is; with ſuch reference to the Alphabets of other languages, as may ſerve to elucidate and explain the ſubject; and with ſuch authorities, as may teſtify its importance. And though, perhaps, it would require a long ſeries of years to improve our Alphabet, by repairing its defects, and pruning away its redundancies, yet certainly the enquiry ſhould not be deemed contemptible; ſince, as a learned and ingenious Member of this Society* well obſerves: "Of all human

* See Eſſays Hiſtorical and Moral, by the Rev. G. Gregory, D. D.

arts,

arts, the moft curious, and apparently the moft difficult of invention, is ALPHABETICAL WRITING."

Now a variety of Alphabetical Sounds, and a copioufnefs of apt words for the greateft number of ideas, may juftly entitle a language to the epithet, *rich*; but in order that it fhould be ftill more nearly allied to perfection, it ought not only to poffefs words and founds, but alfo an orthography; neverthelefs, if the French language be excepted, I know of none which has lefs of orthography, than the Englifh; though it be as nervous and as abundantly fupplied with words of all kinds, as any of the modern languages.

Every one knows, that orthography does not merely fignify fpelling, or putting letters and fyllables together, but the doing fo correctly; and howfoever caprincioufly, or defectively a language may be ufed, as to its orthography, or the juft combination of its elementary characters, yet there can only be one uniform law to regulate it in this refpect: "*et potius ab incorrupto principio, ab naturâ* "*rerum, quàm ab libidine hominum.*"*

In the Englifh language there is a ftrange confufion of vowels and confonants heaped together; in many places redundantly: Diphthongs are not infrequently ufed for vowels; and both are fometimes compelled to ferve as confonants, or rather to rank amongft them by name, though indeed they are not in a

* Ter. Varr. de Ling. Lat. lib. ix.

leſs degree vowels or diphthongs, from being termed conſonants. Now to miſtake theſe and uſe them indiſcriminately and unnaturally, though the words, wherein they are ſo uſed, may, like ſome hieroglyphics, be from habit, well underſtood; yet it muſt aſſuredly be acknowledged as a blemiſh to the appearance, and ſome little impediment to the arts of writing and printing, to employ a ſuperfluity of letters where fewer would ſuffice, if due deference were paid to the ſimplicity of nature, and the analogy of reaſon. For, in order to produce harmony from the combination of principles, whether it ſhould be in painting, muſic, or language; or in ſhort, in any ſubject improveable by art, analogy and proportion ſhould be carefully regarded. "*Quæ* "*enim eſt pars mundi quæ non innumerabiles habeat analo*-"*gias? Cœlum an mare, an terra, an aër, et cætera* "*quæ ſunt in heis?*" *

Should any one, therefore, wiſh to excel in the practice of painting, or of muſic, he ought without doubt, to be well acquainted with the nature and variety of colours, ere he ſhould attempt to mix and ſpread them on his canvas; or with the proportionate and moſt minute diviſions of ſound, ſuitable to compoſition, before he ſhould attempt to write a Solo or Concerto. So in painting words to the eye, it ſeems in the firſt place neceſſary to underſtand the elements, of which, according to their various inflec-

tions,

* Ter. Varronis De Ling. Lat. lib. viii.

tions, they ought to be composed, in order to establish that unity and precision, which should characterize every work of art: Hence such an attention to elements would render language cognizable, as well by the sight as by the organs of hearing, and prevent the errors of one sense, which so often arise (especially when foreigners are acquiring our language) from the mistakes of the other.

It is true, indeed, it may be urged, that our Alphabet, in its present state, has, for at least two centuries, very well answered all the purposes of writers of every description. So, there is reason to suppose, did the Cadmean letters serve three thousand years ago, for the writers of that age, till Palamedes found out that three or four letters more would do better; and perhaps these seemed enough, till Simonides added as many others as Palamedes had done before.*

Habitual error may sometimes be mixed with reason, and mistaken for one perfect whole; but as truth and falsehood can never be so altered as to incorporate together, to analyze appearances, and to separate truth from its semblance, is the certain means of approaching nearer to perfection.

If

* Quippe fama est, *Cadmum, classe Phœnicum vectum, rudibus adhuc Græcorum populis artis ejus auctorem fuisse. Quidem Cecropem Atheniensem, vel Linum Thebanum, et temporibus Trojanis Palamedem Argivum memorant, sexdecim litterarum formas; mox alios, ac præcipuum Simonidem, cæteras reperisse.* Lallemand's Tacitus, vol. ii. page 13.

If any one, neverthelefs, fhould chance to be fo completely fatisfied with our mode of forming words, as to think that there is not *any* room for its improvement, he muft indeed be a very fuperficial, or a very precipitate obferver; fince nothing can be advanced in defence of defects which an eafy inveftigation would enable him to condemn, but, that neceffity alone has fo long retained them. For, indeed, however they may be examined, it is to be feared that the faults of our Alphabet are too inveterate to allow of being, in any fhoit time, effectually repaired, unlefs (which would be vain to expect) all the literature of the Englifh language, worth preferving, fhould be reprinted. This much, however, may be derived from the examination, that it may poffibly excite fome further curiofity and enquiry concerning a fubject, which, without queftion, is not too far beneath the pride of man, or the ftubbornnefs of opinion to inveftigate: "Ne "quis (igitur) tanquam parvæ faftideat Grammatices "elementa: non quia magnæ fit operæ confonantes "à vocalibus difcernere, ipfafque eas in femivocalium "numerum, mutarumque partiri; fed quia interiora "velut facri hujus adeuntibus, apparebit multa "rerum, fubtilitas, quæ non modo acuere ingenia "puerilia, fed exercere altiffimam quoque eruditionem ac fcientiam poffit."*

The

* Quinctill. Inftitut. Lib. ii.

The Hebrews go ſtill further in ſupport of the dignity of letters, as may be ſeen at the beginning of the younger Buxtorf's Chaldaic Lexicon, when they ſay "that there is not a ſingle letter in the law, whereon the fate of vaſt mountains may not be ſuſpended."

If we conſider the facility wherewith, by means of a few letters, the communication of all human ideas is effected, and the moſt important employments of life promoted, all other modes of tranſmitting intelligence and recording the hiſtory and ſcience of the world muſt hold a very inferior place in the compariſon. And yet there are people, whoſe numerous productions are indubitable proofs of their ingenuity and induſtry, who are, notwithſtanding, ſuch enthuſiaſtic worſhippers of cuſtom, that, though they might acquire a readier and more rational method of imbibing and communicating knowledge; prefer, however, in defiance of all its difficulties, their own moſt numerous, complicate, and almoſt unattainable ſcheme of arbitrary characters.

More tardy and difficult, however, than this ſcheme of Chineſe writing (though in repreſenting viſible things more preciſe) muſt that of the Mexicans have been, whereby they recorded all their events; and were enabled to report to Motezuma all that they had obſerved amongſt the Spaniards: "Era eſta ſu modo de eſcribir, porque no alcanzaron "el uſo de las letras, ni ſupieron fingir aquellas "ſeñales, o elementos, que inventaron otras naciones

"para

" para retratar las ſylabas, y hacer viſibles las pala-
" bras; pero ſe daban à entender con pinceles,
" ſignificando las coſas materiales con ſus proprias
" imagines, y lo demas con numeros, y ſeñales
" ſignificativas: en tal diſpoſicion, que el numero,
" la letra, y la figura ſormaban concepto, y daban
" entera la razon." *

How tedious and imperfect would this practice be found if it ſhould be put in competition with the moſt complex alphabetical writing! Though it would be much eaſier to invent a multitude of arbitrary characters than retain the remembrance hereof; yet human invention would be exhauſted in this caſe, ere half the changes of any common alphabet ſhould be completed. Perhaps this may be amply evinced by the following curious theorem, which Mr. Harris has inſerted in his Hermes, a work too well known, to ſtand in need of any additional praiſe: " Mille milliones ſcriptorum mille
" annorum millionibus non ſcribent omnes 24 lite-
" rarum alphabeti permutationes licet ſinguli quotidiè
" abſolverent 40 paginas, quarum unaquæque con-
" tineret diverſas ordines literarum 24." † An inconceivable number; being twenty three places of figures,

* Anton. de Solis Hiſt. de la Conquiſta de Mexico, page 71.

† Quoted by Mr. Harris from Tacquet's Arithmetic. See Hermes alſo upon the ὕλη or matter of Language, from page 316 to page 327.

figures, or upwards of 1480 TRILLIONS of pages; without attempting to calculate the great variety of changes upon each! Hence, from a few characters, words might be formed greatly surpassing the utmost expansion of human ideas.

Since, then, these few elements of words may, from time to time, involve new subjects of importance, as long as this world shall exist, should it not form a part of the business of all who can, however slenderly, assist therein, so to promote their improvement and regularity, that they might become in this, as they nearly are in some other countries, of a definite import? This would give to language that symetry and stability by which it would be rendered intelligible, not only at one particular period, but also easy of access to after ages.

Yet if there be any who imagine that a thorough, philosophical knowledge of language may be obtained without an acquaintance with its elements, they might just as well attempt to descant upon colours without ever having had a perception of light.

Lord Monboddo, whose writings will afford pleasure and improvement to all who peruse them, says, with some point, though with that liberality which should ever accompany science, and which will always contribute no less towards cherishing its growth, than an indulgent criticism will towards the correction of those errors to which all men are more or less liable: "Though I myself think nothing "trifling that belongs to so noble an art, (Lan-

" guage) yet I well know that I do not live in ſuch " an age as that of Auguſtus Cæſar, when Meſſala,* " a noble Roman, and the firſt orator of his time, " wrote a book upon each letter of the alphabet, " and Julius Cæſar, as it is well known, employed " himſelf in writing upon another part of Gram- " mar,† when he had upon his hands the moſt " dangerous war in which he was ever engaged." But " the learned of this age," his Lordſhip remarks with ſome poignant ridicule, " though they be " ſo much occupied with facts of natural hiſtory, " minerals, plants, flies, and reptiles, that they " have no time to apply to the hiſtory and philo- " ſophy of their own ſpecies; yet I ſhould think " that

* The Hiſtory of the Origin and Progreſs of Language, vol. ii. page 239. Concerning Meſſala, vide Ciceron. de Claris Oratoribus, ſub finem. Horace and Tibullus make honorable mention of the ſame great orator, to whom the Ciris of Virgil is inſcribed.

See alſo Suetonius in his Life of Claudius Cæſar, of whom he ſays: Novas etiam commentus eſt litteras tres, ac numero veterum quaſi maxime neceſſarias addidit. De quarum ratione, cum privatus adhuc, volumen edidiſſet. Lib. v. cap. 41. And Tacitus takes notice of the ſame, in Annalium libri xi. capitibus 13 and 14. See likewiſe Juſtus Lipſius upon this ſubject.

† De analogia libros duos.—In tranſitu Alpium, as Suetonius relates. For they were his two books againſt Cato, which he wrote about the time of his battle at Munda, ſo unfortunate for the intereſts of Pompey.

" that they would have fome curiofity about an " art fo exceedingly ufeful, by which the bufi- " nefs of human life is carried on; by which " arts and fciences have been conveyed from man " to man, and from nation to nation, and from " the earlieft to the lateft ages; and without which " they could not have been inftructed in the know- " ledge they value fo much: for how elfe could " they profit by the moft accurate account of " infects, which Reaumur has given in fix volumes " in quarto, containing the hiftory of flies with two " wings, and flies with four wings, with a fupple- " ment to the hiftory of flies with two wings; but " which he very modeftly intitles not a hiftory, " but only *Memoires pour fervir à l'Hiftoire des infectes.**"

In

* Advertifement prefixed to the third volume of the Hiftory of the Origin and progrefs of Language.

A Friend, who was prefent at the reading this paper, has fince obliged me with the following tranfcript, as ftrongly pointing againft thofe who are too confident in their inftinctive knowledge and perfection, to imagine, that difquifitions upon fuch diminutive parts of Grammar can be of any importance:

' I remember to have met with a paffage in a certain ' Writer, which is not at all favourable to the Grammarians; ἐμοὶ πρὸς Φιλοσόφȣς ἐςί Φιλία· πρὸς μὲν τοι σοφιςὰς ἢ γραμματιςὰς ἢ τοιȣ͂το γένος ἕτερον ἀνθρώπων κακοδαιμόνων, ȣ̓́τε νῦν ἐςι Φιλία, μήτε ὕςερόν ποτε γένοιτο.

" My friendfhip I beftow upon philofophers: As to " Sophifts, little grammarians, and fuch fort of fcoundrels,

and

In another place, the ſame learned author obſerves: "That all the works both of nature and of art are "compounds, which the ſenſe preſents to the mind: "theſe it is the buſineſs of ſcience to analyze "and reſolve into their firſt principles, or con- "ſtituent parts. The analyſis of Language into its "elemental ſounds was no doubt a work, and "a work of great art; and after that it was an "ingenious thought to think of noting thoſe ele- "mental ſounds by viſible marks, and of ſpeaking "in that way to the eyes. Language is ſo commonly "uſed, and of ſuch facility in practice, that men "who have not ſtudied the art are apt to think "that there is no art in it: on the other hand, men "of curioſity, who are not ſatisfied with the practice, "but want to know the reaſon of things, find great "difficulty in explaining the nature of language, "and giving a rational account even of the common "parts of ſpeech and of their various uſes. But "there is one ſatisfaction from the ſtudy of the "works of art, and which to the lover of know- "ledge

"and ——— cacodæmons, I neither have, nor ever will "have any regard for them."

'The man abhors grammarians; and grammars, I ſuppoſe. 'But who is the author of this bit of Greek? An extra- 'ordinary perſon, I aſſure you; a projector, a viſionnaire, a 'linguiſt by inſpiration, a crack, a conjurer — in ſhort 'Apollonius Tyanenſis. He is the man; and the gram- 'marians account it no diſgrace to be vilified by a mounte- 'bank.' Jortin's Life of Eraſmus, Note, page 604.

'Vid. Apollon. Epiſt. prim. p. 385. Philoſtrat. Edit. Olear.'

" ledge is an abundant recompenſe for the labour " it coſts him, that we can get to the bottom in " ſuch ſtudy, and diſcover the firſt principles of " the art; whereas in the works of God and nature, " there is a wiſdom and contrivance of which we " cannot ſee the end; and, therefore, I doubt " whether in ſuch matters, the human faculties can " ever attain to perfect ſcience."*

Indeed, the ultimate or ſmalleſt conſtituent particles of matter are ſo envelopped and hidden from human comprehenſion, that I know of nothing better whereby to expreſs my ideas thereof than by believing it poſſible, that the Great Intelligence who formed this world as it is, could alſo form its likeneſs in miniature, and all that it contains of every kind whatever, within a ſpace which might be filled by a particle ſo minute, that it ſhould elude the fineſt ſearch of microſcopic enquiry wherewith, according to our preſent ſtate, we are acquainted! not to believe this, would amount to an aſſertion, that matter could be annihilated merely by diviſion—which would be an abſurdity to ſuppoſe.

But, leaving reflections, ſo far abſtracted from our preſent ſubject, the enquiries are, whether or not the Engliſh Alphabet be defective? And, if it be ſo, whether, as being the baſis of the language, it would be either practicable, or deſirable to regulate it

* Hiſtory of the Origin and Progreſs of Language, vol. ii. page 18 and 206.

it by that accurate and invariable method, which can be acquired only by a due attention to the analyſis and ſyntheſis of ſounds? For this attention would perhaps be the root of greater improvement; inaſmuch as ſound and language ſhould be the inſeparable index of the ſenſe; becauſe, without accuracy therein, a juſt diſcrimination of ideas could not always take place; and certainly, as reaſon can beſt operate when the ſenſes are all in uniſon, contrarieties ſhould not be joined, where an individual truth is propoſed. Words ſhould therefore be analogous in principles, both as to ſound and to appearance.* But, though I may ſay with Mr. Locke,† "that "I am not vain enough to think that any one can "pretend to attempt the perfect reforming the "languages of the world, no not ſo much as of his "own country, without rendering himſelf ridicu- "lous," yet ſomething may be done at every opportunity to favour progreſſive improvement, rather than the corruption of language.

I am well aware that little offers in this matter to flatter our hopes with any early probability of amending

* "The Greeks had, in the whole ſtructure of their "language, a proper regard to the ear, as well as to the "underſtanding; and employed the *whole* power of elemental ſounds to make their language both ſoft and "manly in the pronunciation."

Origin and Progreſs of Language.

† On the Human Underſtanding. Book iii. Chap. 11.

amending the alphabetical characters of our country; ſince prejudice and habit long connected, are ſometimes inflexible opponents to the arguments of reaſon and utility. And, indeed, though the defects of our Alphabet ſhould be univerſally acknowledged, yet its improvement, for reaſons before mentioned, is ſcarcely to be expected in a period of many years. Neverthelefs, why ſhould any one of rational curioſity ſhrink wholly back and renounce the ſubject, as a matter either too perfect and too far privileged, or too mean and forlorn to challenge criticiſm or correction? It would conſume ſome time to enumerate all, who at the preſent are known to have written upon this part of Grammar; therefore paſſing over the names of Varro,* Lucian,† &c. we may take a ſurvey nearer to our own time, and adduce ſome names of authority ſufficient to vindicate the utility of the enquiry, as connected with every branch of learning. Such are Eraſmus,|| Theodore

* Of Terentius Varro enough is extant to cauſe regret that no more of his works have eſcaped the ravages of Time and the viciſſitudes of Fortune.

† Vide *Δίκην Φωνηέντων*, or *Σίγμα* verſus *Ταῦ*. And alſo Jortin's Life of Eraſmus. vol. ii. page 141.

|| The Dialogue by Eraſmus is well worthy of peruſal:

Dr. Jortin, in the ſecond volume of his Life of Eraſmus, page 96, particularly notices it; ſaying, "that theſe three "works

Theodore Beza, Ceratinus, Mekerchus, Lipſius,* &c. The following lines, which Mekerchus writes in his commentary concerning the ancient and true pronunciation of the Greek, are applicable to every language, and by defining what every language ought to poſſeſs, ſhew us how far ours is deficient: "Porro cuilibet Linguæ, ut facilè, ſtatim, et rectè "intelligatur, opus eſſe diſtinctâ, certâ, et inconfuſâ "ſingularum litterarum pronunciatione, ipſa ratio "indicat, et clarius eſt quàm ut probari debeat. "Quandoquidem extra controverſiam eſt, ſingulas "litteras et diphthongos inter ſe planè diverſas eſſe, "et, ut Fabius docet, proprium ac peculiarem "habere ſonum. Fruſtra enim diſtinctæ eſſent "litteræ,

"works (including his Colloquies and his *Ciceronianus*) "will laſt for ever, and be for ever peruſed with pleaſure "by the moſt ſkilful and learned; as long as any portion "of literature and of good ſenſe ſhall remain in the "world."

* Lipſius wrote his Dialogue "De Recta Pronunciatione "Latinæ Linguæ," at the requeſt of the illuſtrious Sir Philip Sydney, to whom it is dedicated, as to one, obſerves Lipſius, who might ſay of himſelf with more propriety than Archilochus did:

> Ἐιμὶ δ' ἐγὼ θεράπων μὲν ἐνυαλίοιο ἄνακτος,
> Καὶ μουσέων ἐρατὸν δῶρον ἐπιςάμενος."

Thus imitated:

> Though I War's Monarch dutiful attend,
> Not leſs am I each Muſe's grateful friend.

" litteræ, ſi ſono nihil differrent. Alioqui propter " ſonorum confuſionem et ſimilitudinem lingua " ſcateret amphibologiis: nec poſſet commodè legi " vel intelligi; ac loquenti ſimul et audienti nau- " ſeam pareret."

Thoſe, however, who have not very aſſiduouſly examined the nature and formation of thoſe ſimple ſounds, of which words are conſtructed, would do well to pay ſome attention to a ſubject, which is as intimately connected with every thing elegant and liberal, as are the concealed foundations with the ſuperſtructure of the moſt beautiful piece of architecture. Now as the elemental ſounds form the foundation, and in ſhort the whole eſſence of language, perhaps nothing would contribute more to ſpread and perpetuate it, than a certain and diſtinct notation of its elements, or ſuch marks, inſcribed or ſuperſcribed, as ſhould indicate the anomalies, to which ſome poor, ſolitary letters are, in our language, ſubjected.

Without doubt the exiſtence of the Greek language for upwards of five and twenty centuries, without any great alteration, may be attributed, in part, to its preciſe orthography, as well as to the excellent genius of thoſe writers, who made uſe of it.*

U Though

* The variety of their dialects makes nothing againſt the regularity of their general pronunciation; for it ſeems certain, that they were all well acquainted with the exact powers of each letter; and, that they added, exchanged, or

Though, after all, it is to be confeſſed that the beſt languages have changed; ſome after having continued for many ages; others in periods comparatively ſhort. And ſuch, from a variety of unforeſeen cauſes, will be the fate of all languages; being, like rivers, in motion; and, like theſe alſo, liable to the corruption and decay of their ſources.*

So far being premiſed, and ſuch competent authorities being brought in view to countenance the attempt, the remaining Section ſhall be allotted to the particular examination of the Engliſh Alphabet, and of the ſounds it ought to repreſent; with a view to prove where it is miſuſed, and to ſhew where it might

or expunged, according to the cuſtom of their dialects, but it is not to be ſuppoſed that ſuch accurate people gave, as we do, a number of ſounds to any individual letter; in this reſpect, the greateſt liberty they ſeem to have taken was that of occaſionally pronouncing a ſhort vowel as a long one, or the contrary (as inſtanced by Martial, lib. 9. epig. xi. Edit. Scriverij.) through a licence aſſumed by their poets,

Et qùos ἄρες ἄρες decet ſonare;

alluding to that verſe, which occurs twice in the Iliad:

Ἆρες, Ἄρες, βροτολοιγὲ, μιαιφόνε, τειχεσιπλῆτα.

Where, however, *the difference of the accent, placed over the firſt word*, ſeems a ſtrong ſupport of Dr. Clarke's opinion, that there is a craſis of ὦ in the firſt ſyllable, for ὦ Ἄρες.

* "Conſuetudo loquendi eſt in motu; itaque ſolet fieri "ex meliore deterior, &c." Ter. Varr. De Ling. Lat. Lib. viii.

might be amended; yet without presuming to offer any thing of my own, as a perfect model for imitation; but only as hints, which others may improve upon.

SECTION II.

A SIMPLE letter, or element, is thus concisely distinguished, in the following words from Diogenes Laertius: *τριχῶς δὲ λέγεται τὸ γράμμα· ὁ τε χαρακτὴρ, τὸ στοιχεῖον, καὶ τὸ ὄνομα, οἷον ἄ.*† This includes

† In Zenonem. Lib. vii. page 471. Edit. Hen. Steph. I have here ventured to alter this passage, which, in the above edition, is printed, ὅ, τε χαρακτὴρ τοῦ στοιχέιου καὶ τὸ ὄνομα. where ὁ χαρακτὴρ τοῦ στοιχέιου, thus joined, signifies only one thing, that is, the *form* of the letter; τὸ ὄνομα another, which is the technical name of the letter. Therefore it seems an error to say τριχῶς δὲ λέγεται, when it appears only διπλῆ λέγεσθαι. The error might have easily originated with some transcriber, who having mistaken the ν for an υ, might have changed the accent and omitted the comma after χαρακτὴρ.

I am aware that this may be proceeding too far; nevertheless it is true, what an eminent writer asserts, that

includes three accidents in every letter; namely its written form, whereby it is recogniſed by the ſight; its elemental or ſimple ſound, by which it reaches the mind, by means of the hearing; and its technical or memorial name, which ſhould not, however, exceed the length of one ſyllable; ſaying rather ſimply, ά. than ἄλφα; in order to avoid the commixture of heterogeneous ſounds with the ſimple, elementary parts of words, which, in ſome languages, are ſo often heavily and unnaturally incumbered. For what affinity have the intermediate letters of ἄλφα with the word, ἁρμονικὸς, unleſs, as it appears, it was ſo named to diſtinguiſh the vowel in its double capacity of being long and broad, by its firſt, and ſhort and more ſlender, by its latter poſition? In naming the letters, as, a; be; ce; &c. the modern languages ſeem to have the ſuperiority.* While the

" nothing hath more contributed to bring literature into " contempt, than the cuſtom, which the Wits and the " fine Geniuſes, real or pretended, have taken up to con- " demn as ſchool-learning and pedantry, citations from " Greek and Latin authors, and philological remarks."

* Mr. Sheridan, in his very excellent Rhetorical Grammar, has judiciouſly prefixed the vowel to all the letters, by which method of pronunciation they can beſt coaleſce with their adjoining letters. Indeed, his Grammar abounds with ſuch a copious explanation of the principles of the Engliſh Language, that having conſulted it only ſince the commencement of this Eſſay, I have much contracted my original plan.

the Ancients have Aleph, Beth, Gimel, &c. Alpha, Beta, Gamma, &c. and of three ſyllables, as Ιωτα. and there are letters, at this time in uſe, named with three ſyllables.

The characters which are, at preſent, made uſe of, to expreſs every ſound in the Engliſh language, are in number twenty ſix. Theſe are well known; and, as the vowels are held to be the firſt of all human ſounds, and conſequently the moſt ſimple; it ſeems fit that they ſhould be conſidered before the conſonants, or ſecondary letters.

Archelaus, the maſter of Socrates, was, we are informed, the firſt who taught that the origin of the voice was a percuſſion of the air.* And it is the

* Πρῶτος δὲ εἶπε φωνῆς γένεσιν τὴν τοῦ ἀέρος πλῆξιν.
Diog. Laert. Lib. ii. in Archelaum.

And Ariſtotle, moreover, where he writes περὶ φωνῆς τῶν ζώων, makes theſe diſtinctions: Φωνὴ δὲ, καὶ ψόφος ἕτερόν ἐστι· καὶ τρίτον τούτων διάλεκτος. Φωνεῖ μὲν οὖν οὐδενὶ τῶν ἄλλων μορίων οὐδὲν, πλὴν τῷ φάρυγγι. διὸ ὅσα μὴ ἔχει πνεύμονα οὐδὲν φθέγγεται. Διάλεκτος δὲ, ἡ τῆς φωνῆς ἐστι τῇ γλώττῃ διάρθρωσις. τὰ μὲν οὖν φωνήεντα, ἡ φωνὴ καὶ ὁ λάρυγξ ἀφίησιν· ὅσα δὲ ἄφωνα ἡ γλῶττα καὶ χείλη· ἐξ ὧν ἡ διάλεκτός ἐστι.
Ariſtot. de Hiſt. Animal. L. iv. cap. 9.

Ariſtotle herein agrees, in moſt reſpects, with his predeceſſor, Hippocrates, the whole of whoſe theory of the voice was too long

the moſt ſimple and equal percuſſion, during particular dilations and contractions of the cavities of the mouth, regulated by the tongue, (but the lips by no means coming in cloſe contact, as they muſt in forming many conſonants) which conſtitutes the vowels. From this, the following axioms may be deduced:

Firſt; that ſound, propelled during any one, uniform poſition of the organs of ſpeech, muſt uniformly be of the ſame ſpecies: thus, in pronouncing A, which, ſounded as in war, is the deepeſt and moſt open vowel we have, the element is the ſame, whether it be ſounded by a whiſper, or by the loudeſt voice. It is, therefore, this one, ſimple

long to be tranſcribed as a note, and perhaps it would not be equally intereſting to every one to read; but the following ſhort relation will ſhew how attentive thoſe ancients were to trace effects to their cauſes (even ſometimes by means of the very accidents, interrupting their regular economy) and thus to enlarge the hiſtory of human nature: *εἶδον δὲ ἤδη οἵ σφάξαντες ἑωϋτοὺς, ἀπέταμον τὸν Φάρυγγα παντάπασιν. οὗτοι ζῶσι μὲν, Φθέγγονται δὲ οὐδὲν, εἰ μὴ τις συλλάβῃ τὸν Φάρυγγα· οὗτοι δὲ Φθέγγονται. δῆλον δὲ καὶ τοῦτο, ὅτι τὸ πνεῦμα οὐ δύναται διὰ τετμημένου τοῦ λάρυγγος ἕλκειν ἔσω ἐς τὰ κοῖλα, ἀλλὰ κατὰ τὸ διατετμημένον ἐκπνέει. ὅυτως ἔχει περὶ Φωνῆς ἴσως καὶ διὰ λέξεως.*

Hippoc. *περὶ σαρκῶν* Edit. Foëſij.

ſimple ſound, from a mere opening of the mouth, which creates a vowel.

Secondly; ſhould any one draw a right-line through a given ſpace, and inſtantaneouſly glance off, and continue the line in another direction, it would no longer be a ſimple right-line; it would be be two contiguous right-lines; and the reſult would be ſome ſort of angle.

And, thus, if any other poſition ſhould follow, with whatever velocity, and during the inſtant of pronouncing any certain vowel, give thereto a different tendence or inflection, the ſound produced would not be a ſimple ſound; therefore, not a mere vowel; it would be a compound of two vowels; and therefore a diphthong.*

Such is our letter I, as pronounced in *clime*, *time*, &c. for it is a compound of two vowels; the firſt of which cannot be exactly expreſſed, but by the ſhort ſound of the open A, or of the O in Joy—the ſecond has the true ſound of the continental I, or Engliſh

* "Diphthongus ita ſolet difiniri à Grammaticis, ut ſit "ſyllaba ex duabus vocalibus conflata ſonum retinentibus. "Ego verò malim dicere, In *unam mixtam vocem* coeun-"tibus (nam alioquin quando diſtinctæ ſunt vocalium "voces, duæ ſyllabæ naſcantur neceſſe eſt) aut hoc certè "addiderim definitioni, Quæ raptim et uno ſpiritu pro-"ferri poſſunt."

Beza De Veteri et Germ. Pron. Græc. Ling.

Engliſh E E. thus: O—I. blended into oi or âi.*

The following words are nearly pronounced with the above, I: Quoif, Quoin, Quoit. I am the more particular upon this character, becauſe, though it is, by ſome, juſtly conſidered as a diphthong in ſuch words as *twine*, *combine*; and as a vowel in ſuch as *win*, *thin*, &c. yet there are many who will contend, that it is in all caſes a vowel—becauſe it ſo appears in writing.† But let any one pronounce this letter, ſlowly, and he will ſoon perceive the difference, between the firſt and latter part of it; he

* Αι *(Græcorum)* non dubium eſt quin Latinorum *ai* reſpondeat, raptim ſcilicet & uno ſpiritu pronunciato, ut poſt α non reſpires, ne duæ ſyllabæ pro una audiantur.

Beza de Veter. et Germ. Pron. Græc. Ling.

† It appears, from Grammars publiſhed abroad for teaching the Engliſh language, that Foreigners have, in a great degree, better analyſed our alphabetical ſounds than in general we ourſelves have, whoſe peculiar buſineſs it ought to be to do ſo. And, thus, M. De Lolme anticipated the account of the Britiſh Conſtitution—"of that happy land," as he ſays, "where Liberty had, at laſt, been able to erect herſelf a Temple." A Temple, which none could defile without a tear—for its rites are the dictates of Benevolence, and its trueſt Guardians are Peace and Concord, who will never ſhut its gates againſt the meritorious and unaſſuming votaries, the fraternal competitors of Freedom and Happineſs.

"The

he will, moreover, be ſenſible of the varied poſition of the tongue, during the latter part of the ſound; but if his ear will not ſuffer him to make this diſtinction, let him preſs upon the tongue with the whole length of a finger, and, at the ſame inſtant, let him attempt to ſound the long I, as it is ſometimes called. One half of this ſound he will pronounce very readily; and it will be as, or nearly as, a ſhort open A or O. The latter moiety of the ſound will be as the I in *field*: And he will be convinced, in completing the ſound, that though the firſt part thereof can be formed without interruption from the finger, yet the tongue will ſtrongly reſiſt and raiſe the finger towards the palate, in forming the remaining portion of the diphthong.

Dr. Johnſon ſays of I, "that it has a long ſound "as in *fīne*; and a ſhort one, as in *fĭn*; and that "it is eminently obſervable in *i*, which may be "obſerved in other letters, that the ſhort ſound

"The Engliſh," obſerves one of the Grammarians alluded to, "have ſix vowels, which have a twofold pronunciation, that is is to ſay, long and ſhort, as:

a	when long, is like	*ah*	In the Ger. lang.	when it is ſhort, like	*a*	In the Ger. lang.
e	- -	*ih*		- -	*e*	
i	- -	*ei*		- -	*i*	
o	- -	*oh*		- -	*a*	
u	- -	*ju*		- -	*o*	
y	ſometimes like	*ey*		ſometimes like *i*.		

" is not the long ſound contracted, but a ſound " wholly different."*

This is certainly true in part: why therefore uſe only one character for two ſounds, *wholly different?* If Dr. Johnſon had reſolved the ſound into its principles, he would have been enabled to give a much more preciſe and ſatisfactory account of this letter. But indeed, this excellent and ingenious Author had been ſo much accuſtomed to the more delightful parts of Grammar—to the compoſition of works, which will bear the teſt of ages; that he ſeemed to forget that the language of ſcience, and the moſt beautiful leſſons of morality cannot be tranſmitted to poſterity, without the aid of letters, included in words; and, therefore, he has treated of this part of Grammar too faſtidiouſly, and conſequently, in ſome reſpects, erroneouſly. He has done much towards eſtabliſhing a ſtandard of words, for ſuch as know how to uſe them; without doing enough for the true diſtinction of ſyllables, by which the language would be acquired by children in half the uſual time, and be of eaſy acceſs to foreigners deſirous of learning it, from whom it is, generally, long withheld by numerous impediments. And moreover, he is rather too

* Dr. Jortin, ſpeaking of the modern Greek pronunciation, in his Life of Eraſmus, vol. ii. page 140, ſays ſomething like this: that "they pronounce the *i* not " broad, as we Engliſh do in *templi;* but ſofter, as we do " in *templis.*"

too ſevere upon all, who would attempt the complete examination of what he, nevertheleſs, confeſſes to have taken "from other Gramma-"rians, perhaps with more reverence than "judgment."

It is but fair, in this place, to ſtate Dr. Johnſon's words, which, however, do not argue againſt an inveſtigation of this ſubject; for the long eſtabliſhment of perverſe habits in forming words, prove nothing againſt the preexiſtence of an immutable eſſence, in reſpect to their elements:

"There have been many ſchemes offered for the "emendation and ſettlement of our orthography, "which, like that of other nations, being formed "by chance, or according to the fancy* of the "earlieſt writers in rude ages, was at firſt very "various and uncertain, and is yet ſufficiently "irregular. Of theſe reformers ſome have endea-"voured to accommodate orthography better to "the pronunciation, without conſidering that this "is to meaſure by a ſhadow, to take that for a "model or ſtandard which is changing while they

X 2 "apply

* Chance and Fancy may very properly form ſymbols of ſounds at any period of the world; but it is moſt certain, that neither Chance nor Fancy ought to be concerned in their application and uſes, which ſhould be fixed by Reaſon, and, when ſo fixed, ſhould be permanent. The *form* of alphabetical characters is of the leaſt importance, though the varieties and neatneſs in this reſpect contribute to our pleaſures: the form of a letter is not its eſſence, any more than body is ſpirit.

" apply it.* Others, leſs abſurdly indeed, but " with equal unlikelihood of ſucceſs, have endea- " voured to proportion the number of letters to " that of ſounds, that every ſound may have its " own character, and every character a ſingle " ſound. Such would be the orthography of a " new language, to be formed by a ſynod of gram- " marians upon principles of ſcience. But who " can hope to prevail on nations to change their " practice, and make all their old books uſeleſs? " or what advantage would a new orthography " procure equivalent to the confuſion and perplex- " ity of ſuch an alteration?

" Some of theſe ſchemes I ſhall however exhibit, " which may be uſed according to the diverſities " of genius, as a guide to reformers, or terrour " to innovators."†

Can any thing be more inconſiſtent, than when he lays it down that, " for pronunciation the beſt " general rule is, to conſider thoſe as the moſt " elegant ſpeakers who deviate leaſt from the " written words"? How will any perſon, not acquainted with the language, be able to pronounce, for example, the words *condign*, *ſubtle*, any

* " But ſuppoſing a language to have acquired its utmoſt " perfection, I ſee nothing that ſhould neceſſarily occaſion " any change." Sketches of the Hiſt. of Man, vol. i. p. 162.

† Dr. Johnſon then gives ſpecimens of orthography, recommended ſeverally by Sir Thomas Smith; Dr. Gill; Charles Butler; and Biſhop Wilſon; which are all ſufficiently fanciful, and wanting in that ſimplicity and accuracy, which every alphabet ought to poſſeſs.

and others of the fame kind? The knowledge of any learned language will be no affiftance in this refpect; for in the Latin, the words are *condignus*, *fubtilis*, &c. Italian, or French would bring him fomething nearer: but to arrive at the knowledge of the vernacular pronunciation, he muft be initiated into the myfteries of the language; and then he will find that the G and B are in no degree founded. The words *jail* and *jailer* are as often written *gaol* and *gaoler*. Shall they, therefore, be pronounced *ga-ol* and *ga-oler*?† To affert, that the pronunciation is moft elegant, which deviates leaft from the written words, would be to fuppofe, that our alphabet is, like the alphabets of the Greek, Latin, Italian, and fome other languages, of an uniform pronunciation. But fo far, on the contrary, is the capricioufnefs of our language, that Mr. Sheridan reckons upwards of feventy different ways, which conftantly occur, for characterizing only *nine* of our vowel founds!* Moreover, for expreffing about thirteen,

* They who could wifh to be well acquainted with the analyfis of the Englifh Language, and the great variety of modes of expreffing even the fimple founds, would find ample information in an attentive perufal of the Rhetorical Grammar, before mentioned.

† In Bell's Edition of that beautiful piece of Philofophy, Pope's "Effay on Man," Epift. ii. v. 237, the word goal, by no uncommon miftake, is printed thus:

"Each individual feeks a fev'ral *gaol;*
"But Heav'n's great view is one, and that the whole."

Here

thirteen, different, ſimple vowel-ſounds, there are no more than ſeven characters; which are applied in all caſes, without any kind of point for diſtinction. Whilſt the Germans, without incumbering their words with many uſeleſs letters, have, by ſmall marks, nicely diſtinguiſhed all the varieties of vowels uſed in their language. So that whoever ſhall have been once taught the genuine ſound of their letters, will find no inſuperable difficulty in reading their language.‡ And certainly particular marks, for the

Here the ſound of one ending depends not upon its own intrinſic form, as it ought to do, but upon the rhyme of the next line. Now if any perſon of a future age were to read the above paſſage, and be obſtinate in pronouncing the firſt ending —*jail,* he, on his part, might ſay, perhaps, that the word, which ſhould chime thereto, was wrong; and, that it ought to be *whale:* however, without ſuch correction, it would be as fine nonſenſe, in blank verſe; for it could not be ſuppoſed that each individual merits impriſonment: and the viſitation of priſons is too rare a virtue for all men to put in practice, however inclined they might be to imitate the examples of a Howard.

‡ The author of an excellent little "Eſſay on Punctuation,"* appears no friend to ſuch a method of defining the ſound of words; but cenſures the French language, and not altogether without cauſe, on account of the multitude of its accents; adding, "that our language has "happily eſcaped this horrid incumbrance, and preſerved "a beautiful ſimplicity." It may be worthy of notice, that law manuſcripts are ſeldom encumbered by what this gentleman has ſo ſucceſsfully written upon, Punctuation; here,

* Printed for J. Walter, Charing Croſs, 1786.

the different modifications of language, are as neceſſary as for directing the various modulations of muſical

here, therefore, in ſome views, the language may be thought more beautifully ſimplified, and more nearly reſembling modes of the firſt antiquity; though it can hardly be doubted, but it muſt, in ſome inſtances, barter perſpicuity for ſuch ſimplicity.

It is certain, that the French are obliged to uſe a great concourſe of accentual marks; having only ſix characters to expreſs all their varieties of vowel ſounds. Perhaps, theſe deficiences, among other motives, might have induced Eraſmus to call it, "*Lingua barbara et abnormis, quæ aliud ſcribit quam ſonat, quæque ſuos habet ſtridores et voces, vix humanas.*"

It would be better, however, to abate a little of the ſeverity, on the one ſide, and a little of the too warm encomium on the other; and then it will be allowed, that the uſe of our alphabet, though not as abſurd as that of the French language, is, nevertheleſs, defective in many inſtances. Though there may be many, who, at firſt ſight, will not allow that it is ſo. For, under the various ſtates of this ſhort life, which, in ſo many ways modify the human heart; difference of opinion, whether concerning things temporal or ſpiritual; things beneath human notice, or ſuperior to its higheſt wiſdom, will ever be as much man's leading characteriſtic, as difference of feature and complexion: he, therefore, who, upon all occaſions, can ſhew the greateſt candour, towards the *inoffenſive* bias of man, and the venial errors of opinion, will afford a comparative indication of his progreſs in the knowledge of the mind: mutual conceſſions are neceſſary to mutual improvement; this truth may be proved by experience, and all men, by turns, may ſtand in need of, and enjoy its advantages.

muſical ſounds: A, *flat*, differs from A, *natural*, and is, therefore, properly diſtinguiſhed by a certain mark, *b*. but, were ſuch note in the key, and no mark added, he muſt poſſeſs a muſician's ſkill and quickneſs of muſical apprehenſion, who, in playing ſuch apparent note, would not, at firſt, miſtake the key, and produce a diſſonance. A well practiſed muſician might alſo, it is true, in a certain degree, ſo accommodate an ill tuned violin, that by his ſkill he ſhould produce ſome melody therefrom; though it is certain, that he could much better, and more agreeably, manage an inſtrument, whoſe tones were well adjuſted: for example, intending to produce the tone, B, he might ſhift his finger to that part of the ſtring, which, if it were in tune, might poſſibly appear a note or two above or below that poſition; ſo, not having a well marked alphabet, we occaſionally turn â into ′a or e; e into ie; I into OI or AI; O into A; and U into the diphthong IU or Ruſſian IO, and alſo into the Hebrew kibbuts.

Concerning the vowel, Y, Dr. Johnſon, in two places of his grammar, gives the two following, contradictory accounts, only one of which can be true:

1ſt. " Y, *is a vowel*, which, as Quintilian ob-
" ſerves of one of the Roman letters, we might
" want without inconvenience, but that we have it.
" *Y* being the Saxon vowel ẏ, which was commonly
" uſed where *i* is now put, occurs very frequently
" in all old books."

2dly. " Y,

2dly. "Y, when it follows a conſonant, is a "vowel; when it precedes either vowel or diph-"thong, is a *conſonant*, as *ye*, *young*. It is thought "by ſome to be in all caſes a vowel. But it may "be obſerved of *y* as of *w*,* that it follows a vowel "without any hiatus, as *roſy youth*."

Perhaps he did not conſider that, like colours and muſical notes, the ſounds of language may break

Y off

* A ſimilar diſcordant account of W is alſo given by the ſame author: "for *u*," he ſays, "we often write *w* "after a vowel, to make a diphthong; as *view*, &c." But how make a diphthong from a vowel and a conſonant, which in another part of his Grammar he ſeems to think that *w* is? As: "of *w*, which in diphthongs is often an "*undoubted* vowel, ſome Grammarians have doubted "whether it ever be a conſonant; and rather as it is called a "double *u* or *ou*, as *water* may be reſolved into *ouater*;— "*but letters of the ſame* SOUND are *always* reckoned conſo-"nants in other Alphabets: and it may be obſerved, that "*w* follows a vowel without any hiatus or difficulty of "utterance, as *froſty Winter*." It follows, therefore, that U in the Latin, Spaniſh, and Italian; and *ou* the French adverb, have hitherto been miſ-named; being all of nearly the ſame ſound—and therefore Conſonants! In the German Alphabet, indeed, the *w* is called *veigh*, and ſounds ſometimes like a weak Engliſh *v*; but moſtly as our *w*. The two vowels of the word *root*, and of ſeveral other words with the ſame vowels, have the ſound of the true and ſimple U or W; but if any one ſhould pronounce the words *blood* and *flood* in this manner, a dialect of ſuch ruſticity would provoke the mirth of an auditory; ſo far does cuſtom, in ſome caſes, pervert the more general analogy of vocal ſymbols.

abruptly; may be in contact as it were; or may ſo coaleſce together that each of theſe predicaments ſhall poſſeſs a ſenſible difference. A red and a blue colour, for inſtance, may be placed ſo near to each other as to appear in contact, without really being ſo; two muſical notes may be played or ſung in that diſtinct manner, which the Italians term *ſpiccato* or *ſpezzato*; or two vowels may be pronounced with a comma between them, and each of theſe modifications may be conſidered as a *hiatus*. Two colours, alſo, as well as two muſical notes, or two vowels, may ſo cloſely approach, as to leave no interval of ſpace or time between each other, and yet may be perfectly defined; but ſhould the union be ſo intimate, that commixture ſhould take place, a purple would be the reſult of thoſe two colours. And as in muſic, when that, which is called a note *de Goût*, or grace, is ſoftened, as it were, without the ſmalleſt interval, into the principal note (which it either precedes or follows) in ſuch a manner, that the

* "Nonnulli effictum fuiſſe volunt characterem Y, "vero ι ad baſin literæ υ vocalis adjecto."

Beza de Germ. Pron. Græc. Ling.

But how then could it be eſteemed as a ſimple vowel, when compoſed of two vowels? It is as reaſonable to ſuppoſe that the modern ſound of the Engliſh y was taken from the Greek diphthong υι which is exactly of the ſame ſound as the French affirmative *oui*, and many other of their words, ending in *ui*, whether a conſonant follow or not. But according to the Engliſh technical name, it is a triphthong, *ouai* or *uai*.

the union of the two can ſcarcely be diſtinguiſhed, ſo exactly parallel is the union of two vowels: and I is like the note *de goût* to the O, in medallion and words of ſimilar termination: as it is alſo, audibly, though not viſibly, to U, when ſounded as in *mute*. In the Ruſſian Alphabet, the ſound is well expreſſed by one type Ю. Many other examples of diphthongs might here be noticed; but, as they are all reſolvable by the ſame criteria,* it may be proper to paſs on to the ſimple vowels, the number of which appears to be naturally ſeven; for ſo many principal variations may be formed, beſide their diminutions, without bringing the lips into cloſe contact with each other: and this number perhaps almoſt all human beings are capable of forming.† And, however novel it may ſeem, I am led to believe that the vowel ſounds have nearly the ſame analogy to the primitive notes of Muſic, as theſe have to the primary colours; and the other varieties of the vowel ſounds can only be eſteemed,

* On the contrary a vowel, or any ſimple letter, admits of no further analyſis, but is, as Ariſtotle || aſſerts, *Φωνὴ ἀδιαίρετος,*

† *Οἱ ἄνθρωποι Φωνὴν μὲν τὴν ἀυτὴν ἀφιᾶσι διάλεκτον δὲ ὀυ τὴν ἀυτὴν.*

Ariſtot. de Hiſt. Animalium, L. iv. c. 9.

|| See Winſtanley's Edition of Ariſtotle's Poetics, page 64.

as in the fame order as the chromaticks of Mufic and Painting:

> " for Nature opens
> " Proportions mufical in all her parts."*

" The proportional breadth of the primary or " prifmatick colours, in the order as they are feen " in the rainb w, is as follows: and anfwers to the " mufical notes oppofed to each colour.

Red	45	Ut	אֵ	E as in Fate.
Orange	27	Si	אֻ	U — in fhut.
Yellow	48	La	וּ	U — in Ruby.
Green	60	Sol	וֹ	O — in Mote.
Blue	60	Fa	אַ	A — in Father.
Indigo	40	Mi	יִ	I — in Shield.
Violet	80	Re."	אָ	A — in Wall.

I thought that this parallel could not be better exemplified than by the Hebrew fyftem of vowels, which in fome refpects is certainly fuperior to any other in ufe; not even excepting that of the German vowels, which is very difcriminate. For in the pointed Hebrew there is always a certain quantity in the fyllables; and whoever underftands the points can make few or no miftakes in the reading,

* See Eudosia, a Poem on the Univerfe, Book V. v. 480. by Capel Lofft, Efq.—fee alfo the note upon the fame verfe; which comprehends the comparifon of colours with the notes of Mufic. And with thefe I have endeavoured to parallel the primary vowels.

reading, as far as is at present known of a language no longer spoken. And even where the Hebrew does change its vowels, accordingly as the inflection and regimen of words may require, there are established rules, whereby to proceed. And those, who will not allow the vowel points to have been a part of the language before the Christian æra, will at least confess, that they were, whatever was the time of their invention, an effort of great genius and nice distinction;* since, in this system, there are all the most useful varieties of vowel sounds; and, in point of proportion, as it were, a diatonic and chromatic scale: For the primitive vowels are seven, and the simple variations are exactly five, beside the sheva quiescent, which is as our E mute: and this agrees nearly with the nature of musical notes.† Thus

* Beza says: "Puncta vocalia ab Hebræis Grammaticis, "divinissimo certè invento excogitata." Indeed what is there to contradict the opinion, that the whole Alphabet might have been of divine origin? Was it not as easy for the ALMIGHTY to give MOSES an Alphabet, as to give him the Decalogue?

The Rev. Gilbert Wakefield observes, "that all the sagacity "and experience of succeeding generations, illustrated as "they have been by a vast influx of additional know-"ledge, beyond the most accomplished of their predecessors, have been unable to superinduce any real improve-"ment upon the *Hebrew* alphabet." On the Origin of Alphabetical Characters. See 2d. vol. of these Memoirs, p. 296.

† "Le Genre *diatonique* est celui de trois qui procéde "par tons et semi-tons majeurs, selon la division naturelle "de la Gamme." Dictionnaire de Musique par M. Rousseau.

Again:

Thus the following ſeven ſeem to be the primary or fulleſt vowels:

7.	6.	5.	4.	3.	2.	1.
אֻ	וּ	וֹ	יִ	אֵ	אֶ	אָ

and the variations are theſe five very ſhort vowels, which

Again: "Le Genre chromatique de Muſique eſt celui qui "procéde par pluſieurs ſemi-tons conſecutifs. Ce mot viens "du Grec χρῶμα, qui ſignifie *couleur*, ſoit parceque les "Grecs marquoient ce genre par des caractères rouges, ou "diverſement colorés; ſoit, diſent les Auteurs, parceque "le genre *chromatique* eſt moyen entre les deux autres, "comme la couleur eſt moyenne entre le blanc et le noir; "ou, ſelon d'autres, parce que ce genre varie et embellit "le Diatonique par ſes demi-tons, qui font, dans la muſique "le même effet que la variété des couleurs fait dans la "peinture." Ibid.

There are very few, I am perſuaded, who will miſunderſtand this theory as a ſuppoſition, that the vowels, in common ſpeech, are muſical notes, any more than the primitive colours are ſuch: ſince muſical notes depend upon the more extenſive powers of the *larynx* and *epiglottis*, this ſerving to the former as the fingers do in performing on the flute, to vary its aperture, and thence conſequently to increaſe or diminiſh the moment of any one given quantity of air propelled through ſuch varied aperture, and thus producing intonation.§ But the vowels have

§ Hippocrates, in his firſt book περὶ διαίτης, ſays that the tongue imitates muſic (γλῶσσα μουσικὴν μιμέεται) whereas the tongue does not ſeem neceſſary to forming tones. One of its principal uſes is the articulation of ſpeech.

which cannot be accurately pronounced unleſs they be joined with their conſonants:

12. אֵ 11. אֶ 10. אִ 9. אֻ 8. אֲ — Beſides the ſheva, 13. אְ

All which ſounds are contained in the following words, under correſponding numbers:

1 War, 2 car, 3 tete, 4 field, 5 vote, 6 rule, 7 nut, 9 8 allot,
11 10 effect, 12 13 written.

Beſide theſe ſimple vowels, the Hebrew has alſo diphthongs, as well as other languages: ſuch as יֹאמַר the future of אָמַר, he ſpoke, and many others.

So much for the Vowels; which, with their varieties, are thus ſhortly proved to be in their moſt ſimple ſtate, TWELVE or THIRTEEN—all of which are conſtantly uſed in the Engliſh language; and yet we have only ſeven characters, without any diſtinctive marks, occaſionally added, to repreſent them in writing; and even two of the

have that breadth or denſity of ſound, which may be exemplified on any monochord, or on the frets of a Guitar, by a view of the proportionate diſtances and places of the notes conſidered abſtractedly from ſound, as is the correſponding breadth of the priſmatic colours.

the ſeven, I, and Y, are equivalent; the former whereof, and likewiſe U, are made to ſerve as often for diphthongs as for vowels.*

Now, as to the conſonants, I ſhall be as conciſe as the ſubject will permit; not dwelling unneceſſarily upon ſuch as always preſerve their genuine and individual properties; but making upon each ſuch few remarks, as appear to have eſcaped the attention of others.

A Scheme of the Engliſh Alphabet is hereto ſubjoined, wherein all the ſimple ſounds are enumerated, and collated with thoſe of the learned and ſome of the principal modern languages; that is, however, as far only as is at preſent known of the pronunciation of languages, no longer ſpoken by

* So indefinite is the knowledge, which children generally acquire, concerning the uſes and exceptions of the Engliſh Alphabet, that it cannot be reaſonably expected, that they ſhould be able of themſelves to read every common word, with ſufficient exactneſs, although they might have been inſtructed for ſome months. On the contrary, in frequent inſtances, they require the conſtant collateral aid of tradition, as if their buſineſs were to be initiated into the myſteries of ſo many hieroglyphics, which had no affinity to the alphabet they had been taught. Now as children may be ſuppoſed in general to poſſeſs a ſimilar capacity, in moſt places, it would be a ſubject of curioſity to inquire in what countries, at what ages, and under whatever other comparative circumſtances the greateſt number of children acquire the beſt and ſpeedieſt knowledge of reading and writing their native language.

SCHEME OF ALPHABETS,

ARRANGED ACCORDING TO THE VARIETY OF SIMPLE CONSONANTS IN EACH.

(To face Page 177.)

ENGLISH.		HEBREW.		SPANISH.		GERMAN.		ITALIAN.		GREEK.		LATIN.		FRENCH.	
Form.	*Sound.*	*Form.*	*Sound.*	*Form.*	*Sound.*	*Form.*	*Sound.*	*Form.*	*Sound.*	*Form.*	*Sound.*	*Form.*	*Sound.*	*Form.*	*Sound.*
A		א		A		A		A		A		A		A	
B	eb	ב	eb	B	eb	B	eb	B	eb	Β	eb	B	eb	B	eb
C	ec	ג	eg	C	ec	C	ec	C	{ ec	Γ	eg	C	ec	C	ec
D	ed	ד	ed	D	ed	D	ed		{ etch	Δ	ed	D	ed	D	ed
E		ה		E		E		D	ed	Ε		E		E	
F	ef	ו	ev	E	ef	F	ef	E		Ζ	ez	F	ef	F	ef
		ז	ez					F	ef	Η		G	eg	G	eg
G	eg [1], eg [2] *	ח*		G	eg [1], egz [2] *	G	eg [1], egz [2] *	G	eg	Θ	eth	H		H	
†gh		ט	et	H		H		H		Ι		I		I	
H	etch	י		ch	etch	I		I		Κ	ek	J		J	
†ch		כ*	eχ	I		J		L	el	Λ	el	L	el	K	
I		ל	el	J*	like χ	K		M	em	Μ	em	M	em	L	em
J	edge	מ	em	L	el	L	el	N	en	Ν	en	N	en	M	em
K		נ	en	LL		M	em	O		Ξ		O		N	en
L	el	ס	es	M	em	N	en	P	ep	Ο		P	ep	O	
M	em	ע‡		N	en		‡ng	Q		Π	ep	Q		P	ep
N	en	פּ }	{ ep	Ñ		O		R	er	Ρ	er	R	er	Q	
	‡ng	פ }	{ eph	O		P	ep	S	{ es	Σ	es	S	es	R	er
O		צ		Q		Q		sc	{ eſh	Τ	et	T	{ et	S	{ es
P	ep	ק	ek	R	er	R	er	T	et	Υ		th	{ eth	ch	{ eſh
Q		ר	er	S	es	S }	{ es	V	ev	Φ	eph	V	ev	T	et
R	er	ש	eſh	T	et	ſch }	{ eſh	U		Χ*	eχ	U		V	ev
S }	{ es	ת	eth	U		T	et	Z	ez	Ψ		X		U	
†sh }	{ eſh			V	ev	V	ev			Ω		Y		X	
T }	{ et			X*		U						Z	ez	Y	
†th }	{ eth			Y		W								Z	ez
†th }	{ edth			Z	eth	X									
V	ev					Y									
U						Z	ez								
W															
X															
Y															
Z	ez														
Simple Conſ.	21		17		17		17		16		15		15		15
Vowels	13														
	34														

by a whole nation. For at this time, in different countries, there is a great diverſity of opinions, reſpecting their pronunciation; people, in each place, adapting their own domeſtic accents to Languages, originating many centuries back, and at the diſtance of many hundred miles.

References to the oppoſite Table.

* All the Characters which are marked with an aſteriſk, have, in ſound, ſome analogy to each other; therefore, whoever is acquainted with one or two of them, will not be very far off the ſound of the others; but the χ, which is added to the Spaniſh and German G, does not ſufficiently expreſs the true ſound, which ought to be heard, previous to imitation: indeed all explanation of alphabetical ſounds depends upon a continual chain of references from language to language, and from one analogy to another.

† Th, gh, ch, sh, th, are all improperly and unneceſſarily uſed as ſymbols of ſimple ſounds.

‡ The termination. NG, (which may follow any vowel, as *ang*, *eng*, *ing*, *ong*, *ung*, and *yng)* being neither a complete *n* nor a complete *g*, but a kind of naſal ſound between the two, it may therefore be added; and the ſimple conſonants will then be twenty-one. For more particulars concerning this character, ſee the latter note upon G.; and alſo Mr. Sheridan's Rhetorical Grammar.—The ſound of ɣ is not well known, and therefore omitted.

Now ſuppoſing, that all the thirteen vowels and variations were uſed in each of the above alphabets, yet ſtill the Engliſh would preſerve the balance of variety. And from thoſe ſimple ſounds are formed all the double ſounding conſonants of the languages enumerated; ſingle characters having been uſed by way of abbreviating compound ſounds.*
" Quum enim inventæ ſint literæ ſimplicibus ſonis
" ſignificandis, neceſſe eſt profectò *in omni lingua*,
" ut quidem commodè ſcribi poſſit, *totidem omnino*
" *literas extare, quot ſunt ejus ſoni ſimplices.* Alio-
" quin ſive plures ſive pauciores fuerint, *et ſcrip-*
" *tioni et pronunciationi magnas tenebras offundi neceſſe*
" *fuerit.* Idque ſolicitè Græcos obſervaſſe, vel hoc
" unum ſatis oſtendit. quòd inter Elenchos Aris-
" toteles nullam *ex literis fallacem* concluſionem
" numerat: quum nihil poſſit frequentiùs occur-
" rere, ſi *uni literæ duplicem ſonum*, vel contra *uni ſono*
" *duas literas* tribueris.

" Simplices igitur Græcæ linguæ ſonos ſexdecim,
" totidémque neceſſarias literas eſſe, ex eo apparet,
" quòd ex reliquis octo qui totidem literis ſcri-
" buntur,

* Perhaps there are more ſimple ſounds attributed above to the Greek than really belong to it: for the Z was formed, it is believed, of DS, and is rather to be compared to the Hebrew צ or German TZ, than to the ז, which, in the Engliſh, and when ſingle, in other modern languages, is certainly a ſimple ſound, differing from S. The ſimple ſounds of the Greek were anciently accounted only ſixteen, including five vowels.

" buntur, alii ſint compoſiti, alii ſuapte natura
" iidem cum compoſitis.

" Sexdecim igitur antiquæ Cadmi literæ ex
" Phœnicia in Græciam illatæ, et totidem ſonis
" ſimplicibus exprimendis repertæ, ſunt hæ, α, ϐ,
" γ, δ, ε, ι, κ, λ, μ, ν, ο, π, ρ, σ, τ, υ. Nam aliæ
" præterea octo illis additæ ſunt partim à Palamede,
" partim à Simonide, videcilet η, ω, ζ, ξ, ψ, ϑ,
" φ, χ; quod nulla quidem neceſſitate factum eſt,
" ſed maximo tamen cum fructu, ut ſcriptio minus
" eſſet laborioſa, magiſque compendioſa."*

Now the conſonants in the preceding number of Cadmean letters are only eleven; but as ζ, ϑ, φ, χ, though aſpirated, are not double, according to the preſent pronunciation, each being eaſily ſounded, during one particular conformation of the organs of ſpeech, by one ſimple contemporary energy of the breath; hence it is evident that the ſimple ſounds may be reaſonably accounted FIFTEEN.

In the German Language there are upwards of two hundred words beginning with *pf*, which character is truly of two letters; the ſound of each being diſtinctly heard, as: *Pferd*, *pflicht*, *&c.*— This, however, even ſhould it really be the genuine ſound of φ, does in no wiſe leſſen the number of ſimple ſounds in the Greek: for allowing that

Z 2 one

* Adolph. Mekerch. Commentar. de Veteri et Recta Pronunciatione Græcæ Linguæ, page 50. copied from Beza de Germana Pronunciatione Græcæ Linguæ, page 3 & 4.

one half of it, that is to ſay *f*, be a ſimple ſound, this the Φ has, as well as all the languages enumerated.

How far the Engliſh outnumbers thoſe languages in variety of ſimple ſounds, I have already endeavoured to ſhew: it remains next, however, to enter into a more particular enquiry concerning each, and this ſhall be done in the order of the foregoing ſynoptical table of conſonants, and firſt of the letter B.*

B.

There is little difficulty reſpecting the pronunciation and uſe of this letter, the Engliſh and moſt other Nations giving it the proper ſound. In the Spaniſh, indeed, it is frequently uſed inſtead of V, to which the Royal Academy of Madrid gives

* Mr. Sheridan, after having enumerated, in a long liſt, the great irregularities of the vowels, obſerves that, "we "ſhall not find the ſtate of our conſonants much better."

"B is often mute, as in—*debt*, *tomb*. C has three ſounds, "as *k*, *s*, *ſh*, in *care*, *ceaſe*, *ſocial*. F has its ſound marked by "two different combinations of letters, *ph* in *Philip*, *gh* in "*laugh*. G has two ſounds, as *gold*, *gentle*. J has the ſame "ſound as that of the 2d. G. *joy*. S has four ſounds, *s*, *z*, "*ſh*, *zh*; in *yes*, *roſe*, *paſſion*, *osier*. T has alſo four ſounds, "*t*, *s*, *ſh*, *ch*, in *tell*, *ſatiety*, *nation*, *queſtion*. X has three "ſounds, *gz*, *ks*, *z*; in *example*, *vex*, *Xerxes*. Th has two "ſounds, *then*, and *thin*. Ch has three ſounds, *k*, *ſh*, *ch*; "*chorus*, *chaiſe*, *chair*. Gh has two ſounds, *g*, *ghoſt*; *f*, "*laugh*; and is often mute, as in *daughter*."

gives nearly the ſame ſound, only ſofter.* In ſome of our words the ſound of the *b* is no longer uſed, though the letter be written; as in dumb, crumb, and many others:

C.

C—To this one letter two different ſounds are given, contrary to all juſt rule.† And it ſerves alſo in the compoſition of what are erroneouſly conſidered as double letters; namely CH, as in *cheer* (from the Italian *cera)*‡ and CH, in *chaſm;* where, however, it only obtains the ſound of K, as in Italian words, the aſpiration being *almoſt* wholly laid aſide.

That

* Of the letter V they ſay: "Su pronunciacion es caſi como la de la *b;* aunque mas blanda, para diſtinguirla de ella, y ſolo tiene uſo en aquellas voces que traen ſu etimología de las palabras latinas, ú otro idioma en que ſe eſcriben con *v*, ú otra letra que ſe convierta en ella, para no desfigurarlas de ſu orígen."

Mr. Harris, in his "Philological Enquiries," gives a ſpecimen from the Formularies of the Greek Court drawn up by Conſtantinus Porphyrogenitus, who reigned in the beginning of the eleventh century, (according to Dionyſius Petavius about the beginning of the tenth) wherein the Greeks at that time uſed, in their Helleniſtic Latin, the B for V, as Κωνσέρβετ Δέȣς ἡμπέριȣμ βέϛρȣμ, &c. for *Conſervet Deus Imperium veſtrum*, &c.

† See Beza or Mekerchus as laſt quoted.

‡ This character and ſound of C H ſeems to have been taken from the Spaniſh, wherein it is exactly the ſame; as in *mucho*, much. But Sancho we convert into Sangko.

That this letter c was of a hard ſound in the Latin, appears, from many inſtances, beyond a doubt. The Roman title, which we, as well as ſome others, have melted into the ſoft ſound, CESAR, as Dr. Johnſon would have it ſpelt, has in the German language preſerved the true ſounds of the conſonants and diphthong, as *Keyſer*. It has often been a ſubject of diſpute among the learned, whether the letter C ſhould be ſounded like K or like S; to this Mr. Pope alludes in the Dunciad:

'T is true on words is ſtill our whole debate,
Diſpute of *me* or *te*, of *aut* or *at ;*
To ſound or ſink in *cano* O or A,
Or give up *Cicero* to C or K.

' But it is ſurprizing that there ſhould be two opinions reſpecting it; for the generally juſt analogy between nouns and their oblique caſes, and between certain tenſes of verbs, is proof ſufficiently evident, that the uſual modern method of ſounding the C, before ſome vowels, is erroneous. Whenever C is uſed as an S, it ought certainly to have ſuch a mark annexed, as might diſtinguiſh it from the hard and genuine ſound. Thus, if we muſt write CÆ-CIAS and pronounce SE-SIAS, there ſhould be a cedilla, or ſome ſuch mark below the ç, as in Spaniſh and French: or, for the ſoft ſound,

ſound, it might remain as at preſent;* and, for the hard ſound, a point might be inſerted within the C, as in ſome Hebrew letters. No difficulty can ariſe from K and Q, though one of them is a redundant letter; becauſe, when they are ſounded, the ſound is always uniform. K before N at the beginning of words is not now pronounced. But in ſuch German words the ſound of the *k* ſtill continues; as *das knie*, the knee.

D.

D—This letter is of an uniform ſound in the Engliſh, but is confounded with the T by the Germans, who ſay indifferently, either Deutſch or Teutſch; hence, from taube, comes the word *dove*, and from thaler, *dollar*, &c.

F.

F. "Has always its own ſound," as Mr. Sheridan obſerves, "except in the particle *of*, where it has "the power of a *v*, and is ſounded *ov*, to diſtinguiſh

* In the Ruſſian Alphabet, K and C are diſtinct; the former having the ſame ſound as we give to it, and the latter that of S.

It appears, from Roman names written in Greek letters, that the C, though not ſo prepoſterouſly uſed, as to ſtand for S, had however two ſounds, but both analogous; that of K, and that of Γ. As Appian, for Caius Cæſar, writes Γάϊος Κᾶισαρ.

" guiſh it from the word *off* in ſound as well as in " ſpelling. Though it is conſtant to its ſound " when ſingle, yet it is frequently marked by two " *ff's*, as in *chaff*, *ſcoff*; ſometimes by *ph*, both in " the beginning and ending of words, as in *philo-* " *loſophy*, *epitaph*; and ſometimes by *gh*, as in " *laugh*, *cough*."

G.

G, Like its neighbour and frequent aſſociate, H, is a letter of apparently great buſineſs in the Engliſh alphabet; but often in fact, is now only a kind of ſinecure retainer, ſuperannuated, as it were, and ſuſpended, by modern cuſtom, from much of its ancient uſage in the language.

It has its genuine, hard ſound in *garland*; it is converted into the Engliſh J, as in *gaol*, *gem*, &c.; in *gnat*, *gnaw*, *oglio*, &c. it is ſilent: before H it becomes hard (like the Italian) as *ghaſtly*, *gherkin*, *gheſs*. The ſame conjunction, *gh*, at the end of words, is frequently ſounded like F, as *tough*. It is ſilent in *dough*, except in ſome northern pronunciation.

The SAME GH, in one or two inſtances, *ſtill* retains its GENUINE, ANCIENT SOUND, which, being uncompounded, I have added to the number of ſimple ſounds in our language; marking it, as ſome of the other aſpirates alſo, with the Greek χ. Such is its ſound in the word LEIGH, the name of a neighbouring town in this County, and alſo

in KEIGHLEY, a town in Yorkſhire.* And this pronunciation is nearly if not exactly that of the Hebrew ח or the Greek, Ruſſian, or Spaniſh X. The latter language has alſo two other characters of *nearly* the ſame kind; as G before an E or I, and J before any of the vowels. The G in the German language has alſo a ſimilar, if not congenial ſound, though with greater latitude; not always depending upon two particular vowels; as *gegen*, *genug*. CH in this language is alſo of a ſound equivalent to the *gh* in Leigh; as *licht*, *recht*, *wicht*, &c. from the ſame roots from which we derive the words light, right, wight, &c.†

A a In

* "The word *Lough*, for a lake," Mr. Sheridan notices, "has a peculiar guttural ſound in the Iriſh pronunciation "not ſuited to Engliſh organs, by whom it is generally "pronounced *lok*."

† The Engliſh alſo, as noticed above, can with great facility pronounce the ſame ſound, when, perhaps, ſo little conſcious of doing it, that they would find a difficulty in forming the like termination to other words, beſide thoſe they have been accuſtomed to write and pronounce in that manner: thus few Engliſh could aſpirate CH according to the Greek and German mode; but to *gh* they readily give that ſound. To moſt words derived from the Greek, and beginning with *ch*, we give the ſound of K. but the initials in the word *charity*, which we derive through a medium of pronunciation very different from the Greek, have a ſound ſtill more remote from the origin than the ſound of the letter K.

In ſuch words as *ſong*, *throng*; and the terminations of participles in *ing*; the *ng*, as before noticed, has a half ſuppreſſed or naſal ſound; as in the words *angering*, *angling*; wherein the ſound of the firſt and ſecond ſyllables are ſenſibly different.*

H.

H Is another hackney (of our Alphabet eſpecially) being applied, like the G, to many jarring offices: But in no one inſtance is any of the four following geminations of letters neceſſary, though conſtantly uſed in a multitude of words. All the ſounds which are characterized by *ch*; *th*, as in than; *gh*; *sh*; and *th*, as in *thane*,† being really five ſimply and individually; as every one may eaſily be convinced of, by ſlowly ſounding each; when the ſame poſition of the organs of language will be ſenſible, both at the beginning

K. The French ſound of CH is alſo retained in ſeveral words; as *chagrin*, *champignon*, &c. Dr. Johnſon ſays, "It is not to be doubted, but that in the original pronunciation *gh* had the force of a conſonant, *deeply guttural*, which is ſtill continued in ſome parts of Scotland."

* The ending of ſome German ſyllables is preciſely the ſame; as in theſe words: *jüngling*, *hoffnung*, &c. It is plain, therefore, that Mr. Sheridan did not advert to this circumſtance, when he was induced to ſay: that "perhaps this ſound is peculiar to the Engliſh language.

† Whatever Φ was formerly, *Ph* only retains, at this time, the mere ſound of F, and no ambiguity attends the preſent uſe of it.

ning and completion of the found. Moreover, each of thefe founds might be continued during the longeft interval of refpiration, and being then inftantly joined with any ufually fucceeding letter, the latter part of any of thofe founds would be as rationally confiftent with fuch fucceeding letter, as would any of the parts which preceded; thus, for example, the word *fhine*, the continuous found of *fh* being reprefented by a continuous line:

fh

Sh——————————————fh-ine.

Now thefe pofitions would not be true, if thofe double characters confifted of double founds; a fingle letter is, therefore, amply fufficient for a fingle found. And it is well known, that the Italians do not require a double letter to reprefent the found of the Spanifh and Englifh CH; for after the powers of their letter C, in its different ftates, have been once known, there are no further exceptions and irregularities, ferving to embarrafs a learner. And hence, one individual found is fufficiently defined by the fimple C; as in the firft fyllable of *cervello*, and the fecond of *uccello*; which laft, as the term for *bird*, is highly expreffive of the chirp of one. And, indeed, man feems, by that fuperior, imitative power, wherewith the Divine Being has qualified him, to have added greatly to his primitive ftock of language; as well as to many of the arts, whofe

growth has more than half concealed their humble, intermediate origins.* The ſolitary web, ſpread from leaf to leaf, might firſt have furniſhed hints for the ingenious and uſeful arts of clothing mankind; the Bee and the Beaver may have afforded inſtructions for forming our habitations; and navigation may have gained its early improvements from that obſervation of the feathered tribe, to which ſuperſtition incited many of the ancient inhabitants of the world.

The ALMIGHTY has, indeed, only endowed with a certain, limitted knowledge thoſe creatures, which he has ſubjected to man; but on man himſelf HE has bountifully beſtowed an innate curioſity and progreſſive capacity, for inquiry and ſcience. This curioſity and this capacity need, however, the guidance of Reaſon, leſt ſhort lived man ſhould find himſelf too long bewildered in the labyrinths of illuſory and fruitleſs objects of purſuit.

But to paſs on to the ſubject. We not only find that the above five ſimple ſounds are characterized by double letters, but, alſo, that CH is ſometimes uſed for

* Eraſmus in his Dialogue, upon the pronunciation of Greek and Latin, has humourouſly made a Bear and a Lion the ſpeakers; and the lion gives a pretty long enumeration of ſounds, imitated by the human voice. See Eraſmi Op. vol. i. page 915. le Clerc's Edit. Hippocrates ſays, that *a rational life is a life of imitation.* *δίαιταν ἀνθρωπίνην μιμέεται.*

Περὶ διαίτης. lib. 1.

for the Engliſh SH.* which, in ſome Alphabets, is marked by one independent character; as שׁ, in the Hebrew, and in the Ruſſian, by Ш, a letter ſomething conſimilar.† Thus, in like manner, every

* See the note upon the latter G.

† Beza ſays "that χ altogether anſwers to the שׁ "with a dexter point, and the French CH (or Engliſh "SH) to that with a ſiniſter point שׂ, and it is his opinion "that the former was improperly called *ſhin*, and that the "latter is falſely confounded with ס. For to the Ephrai-"mites, he obſerves, (as related in the twelfth chapter "of the book of Judges) it happened, unfortunately, "that they knew neither of the ſounds of *chin* (i. e. as he "thinks, χ) but, to a man, pronounced it as ס." Whereas, by a true pronunciation, they might have paſſed unſuſpected of being enemies.

Now by the way, the paſſage, to which he alludes, is not altogether ſo clearly expreſſed in the Septuagint tranſlation, as it admits of being. For the very word ſhould be inſerted, (with an explanation *a*) which was propoſed to the Ephrathites, as a teſt, whereby they might be diſtinguiſhed from the Gileadites, but, as they are not ſo inſerted, it is a proof, among many others, that the Greeks had no letter of the ſound of שׁ, and were, therefore, obliged to leave the ſenſe a little obſcured. The words are briefly compared as follows: *And the Gileadites took the paſſages of Jordan before the Ephrathites: and it was ſo, that when the Ephrathites which were eſcaped, ſaid, each,*

Let me go over, וַיֹּאמְרוּ לוֹ אַנְשֵׁי־גִלְעָד הַאֶפְרָתִי אַתָּה

וַיֹּאמֶר לֹא׃ וַיֹּאמְרוּ לוֹ אֱמָר־נָא שִׁבֹּלֶת וַיֹּאמֶר סִבֹּלֶת

וְלֹא יָכִין לְדַבֵּר כֵּן

The

a As in Matt. chap. i. 23. and elſewhere.

every ſimple ſound ſhould have its own inalienable note of diſtinction. The ſofter *th* Mr. Sheridan has marked by a line acroſs the *h*; as tħ which in the Caſtillian has the ſingle character z. but, if *th* muſt remain, would it not be better to conjoin them ſo as to appear as they ought, one type, with one properly expreſſive name as *the* or *eth*; and ſo likewiſe *eǵ* or *ǵe*; *eſh* or *ſhe*, each with ſome ſmall mark for diſtinguiſhing the anomalies : thus, not to render books unintelligible to poſterity by expunging any thing, all the old conſtructions of the alphabet might be reverently preſerved both by pen and preſs.

Now in regard to the ſound of *ch*; as in *chill*, it does not appear to me that any one has noticed that we have a ſimple alphabetical character expreſſive of this

The words in the Greek, which ought, at leaſt, to be parallel to the above original, are: *καὶ ε̃ιπαν ἀυτοῖς ἄνδρες Γαλαὰδ, Μὴ Ἐφραθίτης ἆ; καὶ ε̃ιπεν ὅυ. Καὶ ε̃ιπαν ἀυτῷ, ε̃ιπον δὴ* ΣΤΑΧΤΣ. *καὶ ὀυ κατεύθυνε τοῦ λαλῆσαι οὕτως.*

This is the ſame as if it were tranſlated:—And the men of Gilead ſaid to them *(individually)* art thou an Ephrathite? And he ſaid, No: And they ſaid to him pronounce then EAR OF CORN: and he could not contrive to pronounce ſo.—Now, would not our Engliſh tranſlation alſo be better thus: and the men of Gilead ſaid unto *each* art thou an Ephrathite? If he ſaid, nay: Then ſaid they unto him, ſay now ſhibboleth *(which ſignifieth an ear of corn)* and he ſaid ſibboleth: for he could not frame to pronounce it *exactly (b)* right.

b. Exactly, or ſome ſuch adverb, the verb being in pihel.

this ſound: yet true it is that ſuch letter is H, whereto we give the name of *aitch*,* and this really comprehending the ſound which is continually preceded by an uſeleſs aſſociate. This ſimple character is called *etch* in the Synopſis.

But to conſider H in its uſually ſimple, unconnected form, as to other conſonants, we are taught that it was originally uſed as a mark of aſpiration by the Greeks,† and continued as ſuch with the Romans as long as their language.

In

* In the Ruſſian language this ſound is judiciouſly marked by *one letter*, and that exactly like our ſmall h inverted thus ч.

† For ἑκατον, they wrote Hεκατον; &c. but afterwards dividing the letter, thus, H, the firſt moiety was uſed for the aſpirate; and the latter was unneceſſarily placed to ſhew that the vowel was not aſpirated.

It ſeems faſhionable, in much modern printing, to lay aſide both theſe marks, as well as the accents, altogether: whereas one of them and the accents are frequently of great uſe, in diſcerning words of ſimilar letters, but different meaning: although it appears true, as many have aſſerted, that there is no analogy between the preſent and the ancient rules of accent, which laſt never offended againſt the rules of quantity. Concerning accents, Ariſtotle ſays: περὶ ὧν καθ' ἕκαστον ἐν τοῖς μετρικοῖς προσήκει θεωρεῖν.* From the preſent uſe of the accents, however, the ear will derive but ſmall aſſiſtance or ſatisfaction: it is the eye which muſt make the diſtinction between words,

* See Winſtanley's Edition of Ariſtotle's Poetics, page 64.

In the Engliſh, too, it generally ſerves as a weak aſpirate at the beginning of words, but even in this caſe, the article *an* is almoſt as often prefixed as if the *h* were ſilent; which deſtroys in a great meaſure the force of the aſpirate, and ſometimes to a hearer gives conſequently an equivocal ſound.* This often occurs, not only in the hurry of converſation, but alſo in the more deliberate acts of writing and printing.

An *owl*, and *an ox*, are not oftener written and printed perhaps of late, than *an houſe*, *an horſe*, *an hiſtory*, and ſuch like words. But this uſe of the article is very unlike its application in the words which the poet gives to King Richard, as noticed by Dr. Johnſon:

> A horſe! a horſe! my kingdom for a horſe!

Where

words, whoſe form and quantity are the ſame; and without the accents, or ſome ſubſtitutes for them, what difference is there between ſuch words as ἀργῆς, *albus*, and ἄργης, *ſerpens*; ἄρκος, *urſus*, and ἀρκὸς, *auxilium*; βίος, *vita*, and βιὸς, *arcus*; θεὰ, *dea*, and θέα, *ſpectaculum*; ψύχη, *papilio*, and ψυχὴ, *anima*; and a great number beſide? The context, it is true, might often lead to the ſenſe, and might as often leave it involved in ambiguity: οὗτοι ζῶσι ſignifies, *theſe men live*; οὔτοι ζῶσι means quite the reverſe.

* Before words, wherein cuſtom has only retained *h* for appearance of etymology, without giving it any ſound, the caſe is very different; as, *an h*onourable houſe, &c.

Where the very hiatus, which ought to be made in pronouncing th s line, fpeaks the ftr ng emotion of a perfon, half breathlefs, through defpair and fatigue, and yet ftill anxious to win the glory of a momentous day.

Some modern caprice would perhaps write,

An horfe! an horfe! my kingdom for an horfe!*

In which cafe it would be no unpardonable miftake, fhould fome part of an audience imagine, that the poor gentleman was calling out for—

A nurfe! A nurfe!

H is ufed alfo after R in fome words from the Greek; as *Rhetorick*, *Rhythm*, &c. but without any found. And after the vowel W in Englifh words it is very common; and is in fuch cafe frequently founded: moreover it is obfervable, as Dr. Johnfon remarks, that though the afpirate follows the *w* in appearance, yet in pronunciation it has precedence, and ought, therefore, to be fo written.† For fuch

* Such article may and ought to be prefixed, inftead of *a*, to all words beginning with the filent *h*; as *an herbal*, &c.

† And it would be equally intelligible, with a better analogy, as:

"*Hwo* finds not Providence all good and wife,
"Alike in *hwat* it gives and *hwat* denies?"

This, at firft fight, appears uncouth; and the eye muft continue to be gratified at the expenfe of propriety.

ſuch aſpirate, the ſemicircular Greek note would be as convenient as the H. * Such novelties, however, notwithſtanding they might help to rectify ſome words, and to obviate the neceſſity of retaining their uſeleſs incumbrances, would, perhaps, gain few advocates among the number of ſuch opinioniſts as fancy, becauſe they will not examine, that the common exuberances, or rather the intruſion of ſome letters, and the improper commutation of others, are no blemiſhes: though truly, as in caſes before alluded to, they impede pronunciation, and might ſometimes throw a ſhade upon the ſenſe.

J.

J is a character which in Engliſh is always uniformly the ſame, whatever vowel it precedes; its ſound is diſtinct, and formed independently of other ſimple ſounds; as is alſo the *ſoft* G, which ought, reaſonably, to have ſome minute ſymbol of diſtinction; a ſcore of which might be deſcribed, any one whereof might ſerve to note the variation of ſound, without incumbring the letter, or miſleading thoſe already acquainted with its various applications.

* The words ὑω, ὑεν, ὑηϱ, are equivalent to *who*, *when*, and *where*. The *whiſtling wind* and "*whirring pheaſant*" may be well written (for example) θε ὑιςλινγ *υινδ*; ὑιῤῥινγ pheaſant. Then why not have uſed our own letters in a manner as little complex?

applications. Both G and J might be called *ge* or *ja*; for the soft sound: and, for the hard sound, G might be called *eg* or *ghe*. A point, within, might distinguish G as it does C.

The sound of the French J is exactly that of *Z-ya*, quickly pronounced as one short syllable: and this compound sound is audible in many English words, where Z precedes a diphthong, of which the first vowel is I (or Y) as in *azure*, equivalent to *aziwre*, for the *u* in this word is a diphthong, and might be conveniently characterized by a point over the *u* in this manner u̇. *Leisure* upon the same principle, by the different pronunciation of the S, comprizes also the same sound, *leiz-your*.

On the contrary, there is no sound of Z in the formation of the soft English G or J, which are pronounced like G in the Italian adverb, *Già*. They are indeed mere unisons, as is each of the following sounds, *eth*, *esh*, *gh*, *sh*, and *eh*, or *etch*, which is collaterally relative to G; and though the letter *d* may be supposed nearly related to J and G, as forming a part of the sound, because we write, *edge*, *judge*, *wedge*, &c. yet the reverse is most probable; for it may be observed that the *d* in those words cannot be completely sounded without dividing the word into *two* syllables, *jud-ge*, making a great hiatus in the pronunciation; which would not be the case if it were congenial with any part of the sound of G. It follows, therefore, that no true assimila-

 tion

tion takes place, between the *d* and *g*, in pronouncing the word *judge*. And, indeed, if the *d* were omitted, it would in no degree, affect the ſound of the *g*: it would be the preceding vowel, *u*, which would be altered — from its ſhort, cloſe ſound, to that of the longer *u*, as in *ruby*.

K.

K may here be paſſed over; as it was noticed under the letter C, which is its frequent ſubſtitute, and, when ſo, ought like other ambiguous letters to have a mark of diſtinction. See page 183.

L.

"L has always one uniform ſound, and is never
"ſilent but when followed by an *m* in the ſame
"ſyllable, as *balm*, *pſalm*. In one word only it is
"ſounded as *r*, colonel—pronounced *curnel*."

By retaining the *l* in ſuch words as *balm*, &c. it ſeems in part that we have followed the original, in the ſpelling, and the French analogy in the pronunciation. Indeed the French formerly wrote *baulme*, *pſeaulme*, &c. with *l*. But in reference to the word *colonel*, the ſound of *r* is in no reſpect heard, unleſs in conformity to an etymology differing from the French, from which we have taken the word:

on

* Rhetorical Grammar, page 17.

on the contrary, it is, as Dr. Johnfon obferves, "generally founded *col'nel*" by the mere elifion of an *o*. And, without the elifion, the *l* has its proper found in the following lines, by Dean Swift:*

> No fubject fit to try your wit
> When you went *colonelling*.

Butler alfo, in the firft Canto of his Hudibras, fays,

> Then did Sir Knight abandon dwelling,
> And out he rode a *colonelling*.

Where, the metre requiring the pronunciation of all the fyllables, the latter word of each couplet cannot be *curnelling*. It is true that in *Spanifh* this office is written, and therefore properly pronounced *Coronel*; but who will fay that this argues a fingle point in proof that L ought to be pronounced as an R?

L unites into an agreeable, liquid found before the conjoined diphthongs IE, EU and U, when this is equivalent to IU, as it is in a multitude of fyllables; and alfo before EW, which has the fame found; as, likewife, IEU in the Englifh pronunciation of *lieu*. Such liquid found is in the words,

* In his anfwer to Ballyfpellin, written by Dr. Sheridan.

words, *lute*, *lubricity*, *alien*; modillon,† pavilion, quintillion, and many other. But in words beginning with *lio*; as *lion* and its derivatives, the firſt letter after the L is the diphthong *ai*, or *oi*, wherewith the L does not blend into the above liquid ſounds, becauſe the ſimple *i* or *y* is intercepted by a vowel of greater denſity; a *diæreſis*, therefore, though not expreſſed, is to be underſtood (as in many

† The LL of Spaniſh words (which ſeems to be converted ſometimes from the Cl, and, at other times, from the Pl of their Latin roots) is applied to exactly the ſame ſound as that of our moſt liquid L, but with a greater latitude; for it precedes all the vowels, except *i* and *y*. And the reaſon why it glides into the liquid ſound before *a*, *o*, and *u*, is, becauſe the pronunciation *ll* is every where followed by the audible, although inviſible power of an *i* or (which is of the ſame ſound) *y* rapidly abſorbed, as it were, by its conſecutive vowel. Such is the nature of *llamar*, *lleno*, *llover*, and *lluvia*. And juſt the ſame is the Italian *gli*, as in *foglio*, *figlia*, *oglio*, whereof the endings are like thoſe of *folio*, *battalia*, *olio*. Mr. Baretti miſtakes, therefore, when he ſuppoſes that we have neither this ſound nor that of *gn*, in *bagnare*, *mignone*; for, as well as the liquid *l* already exemplified, inſtances ſhall be adduced, under the letter N, to ſhew that we alſo have this liquid ſound, aſcribed to *n*, which depends entirely upon a ſtate of the vowels, correſpondent to thoſe which give the liquid ſound to *l*. And this ſoft union of the vowels is ſimilar to the ſynæreſis uſed in Greek poetry, where in the Ionic dialect the ε is rapidly blended with the following vowel, ſo as to form only one ſyllable, as,

Μῆνιν ἄειδε, Θεὰ, Πηληϊάδεω Ἀχιλῆος.

many fimilar cafes) as belonging to the *o* in thofe words, as *lion*, making two fyllables of *i-o:* but for the liquid found the *i* and *o* blend into one fyllable *yo*. All fimple vowels follow their general analogy and irregularity, without influencing the L which they happen to fucceed; as *linen*, *lot*, *lote*, *luftre*, *lynx*. It is an error, therefore, to think that L, or LL, has any *independent*, *liquid* found more than that in *lute:* for the common appearance of words proves nothing; it is the ear which muft analyfe founds, whilft the eye fhould direct the beft means of preferving their diftinctions.

M.

M is always an unifon, and not different from the fame named letter of other languages; except that in French words it is fometimes turned into a found nearly like our *ng*; as, *temps*.

N.

N has very few exceptions to its regularity. The chief is its being in fome inftances filent after *m*.

It is often affociated with the before mentioned diphthongs, *ie*, *io*, &c. and forms the foft found, which, in Italian, is characterifed by *gn*, and in Spanifh by *ñ*, which is an abbreviation of uniform

found;

found ;* ſuch as *aña*, *cañero*, and many others. Theſe ſounds we have; as *champignon*, *dominion*, *onion*, *poniard*, *pinion*, *ſpaniel*, *trunnion*, and others.

P.

P is as regular and conſtant to its ſound as the foregoing conſonant. In Dr. Johnſon's words, "it "has always the ſame ſound, which the Welſh "and Germans confound with B. It is ſometimes "mute as in *pſalm*, and between *m* and *t*, as *exempt*. "PH is is uſed for *f* (at this time) in words derived "from the Greek, as *Philoſopher*, *Philanthropy*, *Phi-* "*lip*."

Q.

Q has been noticed before, under C. Its ſound is almoſt every where uniform in Engliſh words: but in a few, derived from the French, the vowel *u* is not pronounced;† as in *caſque*, *maſquerade*, and ſeveral other words.

R

* Ñ is a character which, before *a*, *o*, and *u*, has the power of *ni* or *ny*; for the word *aña* is reſolvable into *an-ya*. The Gn (in *bagnare*) may alſo be readily expreſſed, in Engliſh letters, thus, *ban-ya-re*.

† The letter U, when pronounced, after Q, always retains its genuine vowel ſound: thus we do not ſay eloq*ew*-ent, but eloq*uent*; not eq*ew*-ator, but *eqwator*, which is the ſame as *equator*. On the contrary, the word *mute*

R.

R is in the Engliſh always nearly the ſame; and but ſeldom ſo ſtrongly vibrated as in ſome French words, ſuch as *Roi.*

S.

S is both in ſound and form a ſerpentine letter, for it "has a hiſſing ſound, in *ſibilation*, *ſiſter*. S "ſingle, at the end of words, has a groſſer ſound, "like that of *z*, as *trees*, *eyes*, except *this*, *thus*, *us*, "*rebus*, *ſurplus*," and ſome others.

"It ſounds like *z* before *ion*, if a vowel goes "before, as *intruſion*; and like *s*, if it follows a "conſonant, as *converſion*.

"It ſounds like *z* before *e* mute, as *refuſe*, and "before *y* final, as *roſy*,"* and ſeveral others which may be ſeen by referring to the Grammars of Dr. Johnſon and Mr. Sheridan.

As to the character *zh*, which this Gentleman applies to denote the ſound of the *s* in *ozier*, and words of ſimilar ending; it ſeems, indeed, analogous to the character *ſh*; but as this double letter, as before obſerved, is, through want of a ſimple character, uſed as the ſymbol of an independent ſound, though it is demonſtrable, by analyſis, to be no further expreſſive of ſuch ſound than as far as neceſſity and cuſtom have united incongruities; ſo muſt

 the

* Dr. Johnſon's Engliſh Grammar.

the character *zh* be equally inapplicable to the ſound of the French *j*.

The miſtake ſeems to have ariſen from having given powers to the conſonant which really depend upon the vowels which immediately ſucceed it: and a ſimple vowel, as already noticed, has no influence; it muſt be a diphthong, of which the firſt part is one of the very ſlender vowels, *i* or *y*; (ſounding as *ee* in *tree)* thus in the words, *azure*, *oſier*, a diphthong follows both the *s* and the *z*; and let the ſound of *z* be given as uſual to the *s* in *oſier*, and the analyſis will be thus: *oz-yer*. *Y* is uſed here, rather than *i*, becauſe the ſlender ſound is oftener given to it than to the latter, and it therefore better anſwers the purpoſe of explanation. *Azure* admits of a ſimilar analyſis; the diphthong *u*, ſounded *you*, follows the *z*—it might therefore be expreſſed thus: *az-your*.

Perhaps alſo the ſound of —*ſion*, at the end of words, depends rather upon a like analogy of the diphthong, *io** or *yo*, than upon the full ſound of *ſh*; as the word *fuſion* may be thus deſcribed: *fuze-yon* or *fewz-yon*.

The termination, —*tion* may be tried by the ſame rule: thus, if the *t* be perverted to the ſound of *s*, it might be nearly expreſſed as follows; *acs-yon*, from *action*.

So

* See page 171, where this character is united, and has the ſound of *you* or *yo*.

So likewise *martial*, *partial*; *conscience*, *patience*; and words of such termination, might be resolved into *mars-yal*, *pars-yal*; *cons-yence*, *pace-yence*; in all which examples the rapid concurrence of the two last syllables, *i-al* and *i-ence*, is indispensibly necessary for giving the required sound.

The word *question*, without perverting the *t*, may be analyzed *quest-yon*.

From this examination it appears, that the full sound of *sh* is not congenial, nor indeed used in the above words; but is rather to be considered as one of the depravities of pronunciation, which time or caprice may now and then have insinuated into the language.

T.

T has always its genuine sound; as in *tablet*, except in the above and similar terminations, and in the word *satiety*, pronounced *sasee-ye-ty*.

V.

V is every where in the English of one equal sound, "of near affinity with *f*. From *f* in the "Islandick alphabet, *v* is only distinguished by a "diacritical point."* Indeed such points would give every requisite precision to an alphabet, and correct the incoherent assemblage of characters.

* Dr. Johnson's Grammar.

X.

X is an unneceſſary ſymbol of two pair of conſonants, *ks* and *gz*. Few miſtakes, however, ariſe from the uſe of it.

Z.

Z, though noticed before, under the letter S, requires thus much further to be ſaid concerning it, that, if it precede a ſingle vowel or any diphthong, beginning with *i*; as *ia*, *ie*, *io*, *u*, it always preſerves its ſoft ſound; and it is ſome ſuch diphthong (*but in no reſpect a conſonant*) which unites therewith to form the ſound of the French J, which is merely a convenient and unperverted abbreviation in that language for the letters *z-ya*,* as it is called in repeating the alphabet; as *jardin* is reſolvable into *z-yar,din*; *joindre*, into *z-ywoin,dre*; *juſtice*, into *z-yous,teece*; making only two ſyllables of each word, as divided by the comma. Whereas the letters *zh* cannot be reſolved in any ſuch ſounds; for *h* can only ſtand for the aſpirate, *ha*, or, if it will be allowed, for the ſound of *etch*. Hence, if *z* ſhould be combined with one of theſe ſounds, what other ſound would be the reſult than *z-ha* or *z-tch*? *Tch* being here ſounded as at the end of the word *thatch*, which might be explained alſo by ſimilar ſounds, though

* In reality it is only *z-y*, which, according to the vowel which may happen to follow, is one or other of the following ſounds: *z-ya*, *z-ye*, *z-yee*, *z-yo*, *z-you*.

though differently written, in other languages. For indeed no one language can ſufficiently explain its own ſounds unleſs *vivâ voce*; therefore, in order to give any explanation upon paper, continual reference muſt be had to analogous ſounds in ſome other language; for as the adamant muſt be applied to illuſtrate every gem of the ſame kind, ſo, to explain one language, aſſiſtance is to be ſought for in others, as has been done in the courſe of this Paper: and if the arrangement of the Alphabets *(oppoſite page* 177*) be correct, or *nearly ſo*, then may the Engliſh be allowed to poſſeſs, in that table, the greateſt number of

* Having frequently thought, that machinery might be conſtructed, by an ingenious artiſt, for imitating the ſounds of the human voice, as well as organs have been formed for the imitation of the tone and powers of various muſical inſtruments, I was not greatly ſurprized at finding, by a paragraph in the General Evening Poſt of May 31, and by an account in the Analytical Review for the laſt month (June) that a M. Von Kempelen, of Vienna, has lately invented ſuch a machine, and publiſhed a deſcription of it, with plates. Experiments therewith would incontrovertibly decide upon the nature and comparative powers of each language it may be brought to imitate. At preſent "it is ſaid to give correctly the ſound of all the vowels "and all the conſonants; but the latter are combined "and expreſſed with ſome difficulty. Of conſequence "the ingenious inventor has found it better ſuited to "*Italian*, *French*, and *Latin*, than to his native language. "But he has hopes of introducing conſiderable improve-"ments, and arranging it in ſuch a manner, that it may "be played upon with keys, in the manner of an Organ, "and with equal facility."

of elemental ſounds. But ſounds alone, without a ſkilful mixture, and apt diſpoſal into words, are not enough to give ſuperiority to a language in any greater degree than merely as a greater variety of colours would excel a judicious deſign in *chiar-oſcuro*,* or as the wild concurrence of many muſical tones would ſurpaſs the ſcientific touches of a few well tuned notes. The harmony of colouring is perhaps a thing not yet completely underſtood: painting by the eye alone, may be like playing upon an inſtrument only by the ear; when neither all eyes nor all ears can be equally correct.†

If ſuch things be ſo difficult, how much more ſo muſt be a knowledge of the complete harmony of the far more numerous elements of language, taking conſonants and vowels together. Such a knowledge may, poſſibly, be reſerved for man, as one part of his expectations in the ſpheres of future happineſs.

As the fallen leaves and ſcions of the foreſt are, at one time ſcattered abroad, and again driven together

* This is only to be underſtood as far as it relates to the ear; for it is ſufficiently evident, that ideas may be conveyed to the mind by the moſt unpoliſhed languages; nevertheleſs it is always moſt agreeable when ſounds ſeem to harmonize with ideas. Mild and gentle thoughts ſhould not be uttered with tones of aſperity; nor ſhould ſoft words be uſed for expreſſing the boiſterous paſſions.

† See the relative harmony of muſical notes, colours, and vowels, page 172.

gether by alternate gufts of wind, fo have emigrations and fhipwrecks, and the ftorms of invafions and conquefts, fcattered over the globe an aftonifhing multitude of the half mutilated germs of language; which, taking new root, have continually favoured the fortuitous change and affemblage of words, thereby defying all conjecture, as to what the precife form of language was, before the confufion at *Babel:* nothing occurs, however, to prohibit the admiffion of an hypothefis, that it was, at firft, as HE who gave it is, PERFECT.

And, indeed, the Holy Scripture fo far informs us, that, previous to the change at Babel, "*the whole earth was of one language and of one fpeech.*" * How, then, is to be reconciled with this account, fome paffages of the preceding chapter? As at verfe 31ft. † "Thefe are the fons of Shem, after their families, after their *tongues*, in their lands, after their nations." Why after their *tongues*, when it is related, that there was at that time (and the whole fucceeding context fupports this paffage) only one language over all the earth? Novice as I am in the original language of the Sacred Writings, I fcarcely dare to hazard any opinion upon thefe feemingly contrary readings, without very great diffidence. I appeal, however, to the learned in the language, whether tranfcribers might not have miftaken, even the three times, one of the following

* Gen. xi. v. 1. † And alfo at v. 5. and v. 20.

lowing words for the other: that is to ſay לְלְשֹׁנֹתָם for לְשְׁמֹתָם the former word ſignifying, according to their *tongues*; but the latter word, according to their NAMES.*

It may be oppoſed to this, however, in order not to admit raſhly any ill founded or premature opinion, that the paſſage, as it is, notwithſtanding its apparent priority, through ſo many ages and tranſlations, ought, perhaps, to be received rather as an anticipated regiſter of perſons and events immediately ſucceeding the general confuſion of ſpeech, than as relating to time antecedent.

So

* I cannot help expreſſing, in this place, an earneſt wiſh, that it may become as faſhionable, with all profeſſors of the benign principles of Chriſtianity, to read the ancient volume of Sacred Hiſtory in the original words, as it is to read, in their reſpective languages, the genealogies of *Heſiod*, or the philoſophy of *Lucretius*. And it would certainly be much leſs difficult to do ſo.

Numerous are the guides thereto, printed in Latin. And, with the laudable view of more generally promoting ſuch knowledge, a few learned men have at different times deſerved the thanks of their country, for publiſhing alſo eaſy directions for the attainment of the Hebrew, without any previous knowledge of the Greek or Latin. See ample and convincing reaſons for giving a ſmall portion of time to ſuch ſtudy, in the prefaces to Robertſon's "Gate, or Door to the Holy Tongue," firſt printed 1653; and Dr. Bayley's "Entrance to the Sacred Language," printed 1782.

So far upon the ſubject of the comparative varieties and abuſes of our Alphabetic Characters; but, ſo far, within a much more contracted compaſs than the extent and importance of inquiry ſtill allows: yet as an attention to this Society urged the contribution of ſome paper to the common ſtock, ſo now ſeveral conſiderations exact the concluſion of this Fragment.

On the ACTION *of* METALLIC OXYDES *and* EARTHS *upon* OILS, *in low Degrees of Heat.* *By* MR. PETER HENRY. *Communicated by* MR. THOMAS HENRY, F. R. S. &c.

[READ NOV. 16, 1792.]

THE high degree of colour, poſſeſſed by many of the expreſſed and fatty Oils, rendering them unfit for ſeveral uſes in the Arts; it appeared to be a deſirable object to diſcover a mode of depriving them of their colouring particles.

For this purpoſe the following Experiments were inſtituted.

1. Two ounces of Sperma Ceti Oil were digested, with one drachm of white arsenic, in a heat of 180° of Farenheit, during six hours; and left to stand till morning. The oil was then perfectly clear, and colourless, and much heavier than it was previously to the experiment. A great part of the arsenic, however, remained undissolved, at the bottom of the digesting vessel.

2. Two ounces of Linseed Oil were digested with one drachm of white arsenic, under the same circumstances with the former. In the morning very little alteration being perceived in the mixture, it was exposed to a somewhat greater heat. In two hours the oil appeared brighter, and clearer, much of the arsenic being dissolved; but it yet retained a great part of its original colour. There was a considerable deposition of mucilage; the arsenic, which remained undissolved, being tinged of a light yellow colour.

3. Green olive oil was treated in a similar manner with the Sperma Ceti oil, and attended with the same result.

4. Thick train oil was digested with a drachm and half of white arsenic. No great alteration was observed in the colour of the oil, though it was evidently rendered clearer and more limpid.

When the oils were at the greatest heat, a brisk effervescence took place in all of them, upon shaking up the bottles, but immediately discontinued on the arsenic being suffered to subside. When poured

on

on the hands, they inftantly fhrivelled the fkin, and were either abforbed, or foon dried up. Two phials of Nos. 1 and 2 being left expofed to the action of air and light, for fome months, were not in the leaft changed.

As it was evident, that a confiderable portion of arfenic was diffolved in all the foregoing experiments, I wifhed to fee, if it could be precipitated; and at the fame time the oils be left pure, and deprived of colour; though with no great hopes of fuccefs, from the known property of the mineral acids to render oils thick and difcoloured.

5. Part of No. 1 being poured into a phial, three or four drops of ftrong vitriolic acid were added. The arfenic immediately precipitated, leaving the oil as pure and colourlefs as before.

6. The fame quantity of vitriolic acid being added to Nos. 2, 3, and 4, the arfenic was in like manner precipitated. No. 2 feemed even clearer than before the addition of acid.

7. Nitrous acid being added, in the fame proportion with the vitriolic, the colour of all the oils was inftantly changed to a dark brown, except the Sperma Ceti oil, which was not much affected; the train and lin-feed oils fuffering the greateft change. In all of them a flight effervefcence took place.

8. Marine acid occafioned a precipitation, which foon rediffolved, in all of them.

9. Both the fixed alcalies immediately coagulated the oils, the water, in which the folution of alcali

 was

was made, subsiding to the bottom of the vessel, along with the arsenic.

10. Three ounces of Sperma Ceti oil were digested with one drachm of litharge, during six hours, in about 200° of Farenheit. The oil became much clearer than before the experiment, but not near so colourless, as when treated with arsenic. The litharge was changed to a white colour. Part of the oil being poured off, and the heat afterwards increased, it soon became thick and high coloured.

11. Lin-seed oil exposed to the same degrees of heat, under similar circumstances, underwent the same changes.

12. Train oil was little affected in low degrees of heat, but in higher degrees, became discoloured.

13. A few drops of vitriolic acid being added to a portion of No. 10, before the heat had been encreased, the litharge was precipitated, and the oil left pure and clear, though not quite colourless.

14. Vitriolic acid being added to the lin-seed and train oils, No. 11, and 12, a very small precipitation of the litharge took place, probably owing to the heat not having been sufficiently great to dissolve it in large quantities, which had been found to be the case with the same oils, when digested with arsenic,

15. Nitrous acid, when added, instantly changed the colour of all three to a dark brown; the oils No. 11 and 12 became thick and glutinous.

16. Marine

16. Marine acid precipitated the litharge. Upon being left to ftand, the lin-feed and train oils affumed a much darker hue, than they had previous to the addition of the acid.

17. Alcalies coagulated the oils, as in the former experiments with them.

18. Two ounces of Sperma Ceti oil and half a drachm of red lead were digefted during eight hours. The oil feemed not in the leaft changed; but a fmall quantity of the lead remained fufpended, and gave it a flight pink caft. The heat, the next day, was gradually increafed with as little fuccefs, till the oil being brought to nearly a boiling heat, it became dark and difcoloured.

19. Lin-feed oil was tried in the fame proportions, with the like refult.

20. Train oil was treated, in the fame mode as the others, with one drachm of red lead. On increafing the heat, it formed a very thick, dark coloured mafs.

21. White lead, and the oxyde of copper, which is formed upon the diftillation of acetated copper, had the fame effect with the red lead. But lefs of the oxyde of copper appeared to be diffolved, than of thofe of lead.

Not meeting with the fuccefs, from the digeftion of the oils with the metallic oxydes, which I was at firft led to expect, I fubmitted them to the action of different pure aërated earths under the fame degrees of heat.

22. Two

22. Two ounces of Sperma Ceti oil, and one drachm of the earth of Alum, precipitated from a folution of Alum, by the vegetable fixed alcali, were placed in a fand heat from 180° to 190° of Farenheit, and fuffered to remain there during three hours. The oil became clear and colourlefs, the gluten having precipitated with the earth to the bottom of the veffel.

23. Two ounces of linfeed oil and one drachm and a half of pure clay were fubjected to the fame degree of heat as the Sperma Ceti oil. This oil likewife, became very clear, and much lefs coloured. A confiderable depofition of mucilage was obferved upon the furface of the clay. The combination of the mucilage with the linfeed oil appeared to be much ftronger, than that of the Sperma Ceti oil with its gluten.

24. Train oil was likewife rendered much purer by digeftion with the fame earth, but was in no degree equal either to the Sperma Ceti, or linfeed oils.

25. Both aërated and pure Magnefia precipitated the mucilage, whilft the oils continued warm; but as they cooled, the mucilage and magnefia rofe and mixed again with the oils.

26. Ten grains of pure calcareous earth being added to one ounce of each of the oils, in the cold, turned them thick, and dark coloured.

27. Aërated calcareous earth had little effect upon the oils, either heated or cold.

In

In all thefe experiments with the earths, not the fmalleft particle feemed diffolved, as on the addition of any of the acids, they inftantly changed to a very dark colour. Thofe oils to which the nitrous acid was added, became much darker than thofe in which the metallic oxydes had been digefted, and to which the fame addition had been made.

It is well known, that oils obtain the property of drying more quickly by being boiled, either alone or in conjunction with metallic oxydes, and argillaceous earths. Oil, according to M. Lavoifier, confifts of Hydrogene, or the bafis of Inflammable Gas, and Carbone, the bafis of Carbonic Acid, or fixed Air. The metallic Calces confift of the Metal united to Oxygene, or the bafis of pure air. According to this fyftem of Chemiftry, the Metal when boiled in oil gives up Oxygene to it, while the Mucilage of the Oil unites to the Metal. It feems therefore propable, that in high coloured Oils, the Carbone is fuperabundant, and that by digefting the calces of Metals, in a lower degree of heat, a part of the oxygene of the calx may combine with the fuperfluous Carbone, and, forming Carbonic Acid, tend to diveft the oil of its colour, while the oxyde, attracting the mucilage, may contribute to the fame end.

How far this theory may apply to the explanation of the foregoing experiments, I do not pretend to determine. It is remarkable however, that one of the earthy fubftances, viz. the alumine, which is not known to contain either oxygenous or carbonic

gas,

gas, de-coloured the oils more powerfully than moſt of the metallic oxydes, and equally with any of them. This earth has a ſtrong attraction for colouring matter, and on this property depends its uſe in dying.

But on the ſuppoſition that the above theory is juſt, it may be expected not only that the oil may be deprived of colour, but that rancid oils may be reſtored to ſweetneſs by the metallic oxydes. My Father formerly found,* that rancid oil, expoſed to ſtreams of carbonic gas, was ſweetened. The ſame effect may be produced by the ſame gas formed in the proceſs; and indeed, though I was not particularly attentive to this circumſtance, I thought the train oil was diminiſhed in rancidity; and the Sperma Ceti oil, which was kept for ſeveral months, after expoſure to heat, continued ſweet.

Another circumſtance, worthy of remark, is, that though concentrated vitriolic acid, on addition to oils, blackens them, and gives out a ſulphureous ſmell; yet when dropped into oils, in which the metallic calces have been digeſted, it combines with the calces, and precipitates them, without either diſcolouring the oils, or changing their odour.

* Henry's Experiments and Obſervations, page 129.

ADDRESSED TO DR. PERCIVAL.

October 30*th*. 1792.

SIR,

I have tranſmitted to you the following account of an ancient Mode of Sepulture, that has taken place at one particular period in this country. Your communicating it to the Members of the Literary and Philoſophical Society of Mancheſter, will much oblige,

Sir,

Your moſt obedient Servant,

ALEX. COPLAND.

King's Grange, in pariſh of Urr, Stewartry of Kircudbright.

[READ NOV. 30, 1792.]

THE tumuli or heaps of ſtones thrown promiſcuouſly together, called by the people of this country *Cairns*, being more frequent in this diſtrict than in any other part of Great Britain, there have been frequent opportunities of late years to examine their contents, from the Proprietors carrying away the ſtones, in order to conſtruct dry ſtone fences,

 and

and other buildings neceſſary for the improvement of their lands. About the middle of the Cairn, and on a level with, or a little elevated above, the earth's ſurface, there are always ſeveral thin flat ſtones laid horizontally in a circular form, with their edges cloſe applied together, without any cement, upon which are generally found entire bones, their fragments, or reddiſh coloured earth, like aſhes, and ſometimes entire urns, pateræ, or clay veſſels, ſlightly burnt, turned with their mouths down, over aſhes or fragments of bones, that appear to have been ſubjected to the action of fire. The heads of ſpears and arrows, both of braſs and iron, with large rings* of theſe metals, have, at times, been met with. Theſe urns or pateræ are ſeldom quite entire; they, and the aſhes or fragments of bones, are generally ſurrounded by flat ſtones, ſo laid, without any cement, as to form niches about one foot and a half long, by ten or twelve inches broad, and from twelve to fourteen inches deep. But the ſize of theſe diviſions varies greatly. In ſome inſtances, they are more than three feet long by two broad, in which the bones are always found more entire; but in others they are very ſmall, when they are found to contain no fragments of bones, but only a little red coloured earth, like aſhes;

* Theſe rings were of a ſize that would have ſuited the ends of their ſpears.

aſhes; and, in a few caſes, theſe diviſions have been obſerved to be conſtructed in a circular form. The number of theſe niches varies, from two to twenty, or more, under one Cairn. No regularity appears in the laying of the ſtones, except that the baſe is always filled up by large, round ſtones, laid in concentric circles round the above-mentioned pavement of flat ſtones; all the remainder of the Tumulus being conſtructed of globular ſtones thrown together, from the ſize of (or a little larger than) a man's head to that of his fiſt, and without any flat ſtones at top; but the Cairns generally put on the appearance of perfect cones, ending moſtly in one large round ſtone at the apex. In many of them ſmall fragments of bones are found equally diſperſed through every part, which, with their frequency in this corner, there being about a hundred of them in the neighbouring pariſh of Croſmichael, and one or two at leaſt in each farm through the greateſt part of this pariſh of Urr, tends to ſhew that theſe Cairns have been the common Cemeteries, or places for depoſiting the bones of the dead belonging to the whole neighbourhood. They are always ſituated on ground a little elevated above that which ſurrounds them. There is reaſon to conclude, that wherever the remains of any Chief of a Diſtrict, or Founder of a Clan, came to be depoſited, not only the reſt of his Family, but alſo his whole

 Dependents

Dependents or Clan would wifh to have their bones depofited in the fame fpot.

From the people in this country having for a long time very little intercourfe with their neighbours, as Galloway continued feveral hundred years an independent Sovereignty from the reft of Scotland,* being one half furrounded by the Sea, and the remainder by ranges of very high Mountains, it is probable that they continued the practice of burning their dead, longer than in other parts of the Ifland, and, in all probability, for fome time after their converfion to Chriftianity. From the following defcription of a Cemetery, that feems to partake of a mixed nature, viz. both of burning and inhuming, and from the inftrument of iron being found almoft perfect, and very little hurt by ruft, which appeared to have been ufed for confuming the corpfe, with a fmall quantity of fuel, it is probable that the burning of dead bodies has not been in difufe fo many hundred years as is generally imagined.

Having occafion to build a dry ftone fence on my ground, the workmen, in order to get ftones, eafily went for that purpofe to what had the appearance of an old inclofure. It was fituated on a piece of ground

* See a Differtation on the Kingdom of Galloway in Archæologia, vol. 9th. of the Antiquarian Society, by Robert Riddell, Efq. of Glenriddell.

ground nearly level, but ſhelving a little to the South-weſt, about a quarter of a mile Eaſt of the little river of Urr, and nearly ſurrounded with eminences, or higher parts of the ground; in that reſpect was different from Cairns, two of which were ſituated on high tops, at only about three hundred yards diſtance, one on the North Weſt, and the other direct Eaſt; but it rather partook of the ſite of the later burying-grounds, in being more ſequeſtered and recluſe. It was of the form of an oblong ſquare or parallelogram, rounded at the corners, each of which lay to one of the cardinal points. The fence appeared to have been complete all round, except in the midſt of the South-Eaſt ſide, where there was a breach of about five or ſix feet, that appeared to have been the entrance or door. There was no appearance of any other building of any kind, as the fence was the ſame throughout, and no fragments of mortar or other cement were to be ſeen.

It was conſtructed in the following manner: There were three rows of large ſtones ſo placed all round, that their centres were exactly three feet and a half diſtant from each other; the interſtices were entirely filled up by ſmaller ſtones, of ſuch a ſize, as a man could eaſily lift and throw to ſome diſtance with one hand. Theſe ſmall rounded ſtones were continued both on the inſide and and on the outſide of the large ones for nearly three feet and a half,

ſo

fo that the fence would have been pretty exactly fifteen feet broad all round. It appeared higheft nearly above the moft external circle of large ftones, and gradually diminifhed in height as it approached the centre; at firft it feemed doubtful whether the fmall ftones were fo fituated from their having fallen down from a higher pofition; but there was reafon to think they had been originally fo, from their exact fimilarity in every part of the fence. Amongft the greateft part of the internal edge of the fence, there was a confiderable quantity of fat earth, that run in below the fmall ftones very near four feet, fo as to approach the large ftones, forming the innermoft circle; it was divided into fpaces of two or three feet wide, and nearly fix feet long, by means of thin flat ftones placed perpendicularly in the earth, and a pavement of the fame ftones was moftly found at the depth of from one foot and a half to two feet and a half from the furface. In the mould, fmall pieces of bones and of charred wood were at times met with; and in one place the fragments of a patera or urn were to be feen. Upon removing the ftones near to where the entrance had been, three long pieces of iron were difcovered, lying clofe together about the bottom of the fence, which, although the perfon who found them did not take notice of any particular inclofure conftructed for containing them, muft have been depofited in fuch a proper fpace, as they were of a great length, and

and all in the ſame direction with the middle line of the fence. They were in ſo entire a ſtate, that the country people took them to a Smith, and got them hammered into inſtruments for country purpoſes, at the time that the Farmer who had found them was delirious from a febrile attack of which he died, and to whom I had given ſtrict charges to preſerve them in the moſt careful manner. In order to aſſiſt in deſcribing the Cemetery and this Inſtrument, I made a rough ſketch of the firſt on the ſpot, and the laſt I have figured from the recollection of myſelf and others, who had examined them.

Fig. 1ſt. repreſents a perpendicular ſection of the fence, being at a medium about three feet high above the ground, to ſhew the manner in which the large and ſmall ſtones were depoſited, and the earth divided by flat ſtones on the inſide, together with the ditch, at preſent filled up with earth, but which is diſtinctly to be traced all round, nearly at an equal diſtance from the fence. A, B, C, the three rows of large ſtones exactly the ſame all round. E, the niche or ſpace for ſepulture. D, the portion of original till at the end of it, that muſt have prevented the aſhes and bones, when mixed and covered with ſome earth, from falling into the ditch G; and F a ſection of the ſurface of the triangular hearth, as it appears near the South-weſt corner.

Fig.

* Fig. 2d. reprefents one of the branches of what may be called a Comburator;* three of them were found near the entrance, at the place marked A in the ground plan, Fig. 4th. They were in every refpect alike, being rather more than feven feet long, of a ftraight ftalk or pole, with an obtufe bend near their upper end, where they became broad and palmated to the full extent of three inches near the extremity, being concave in a fmall degree on the under fide, and equally convex on the external or upper fide, and where broadeft, they were perforated fo exactly with a perpendicular hole, that when applied together in a triangle, they could be retained firm in that pofture by an iron pin, fo as to put on the appearance of a truncated cone full feven feet high from the ground; fee Fig. 3. When thus erected, their under ends ftood at the angles of an equilateral triangle, about feven feet diftant from each other, and when ufed, their upper ends, we muft fuppofe, were fecured by an iron pin, which was turned up below like a hook, as reprefented at A, and their under ends, from terminating in a point or pike, were ftuck and fecured in the hard till or triangular

* N. B. The Fig. is rather too broad along the pole for its length.

triangular pavement.* Their general thicknefs was about an inch deep by half an inch broad, being deepeft from the external to the inner fide, fo as to refift preffure beft when made in that direction.

Fig. 4th, reprefents the general ground plan of the cemetery, being an hundred and eight feet wide over the fence, by an hundred and forty-eight long. A, the entrance at the fouth-eaft fide. B B B B, the fence. C C C, &c. the divifions marked out by the thin flat ftones fet upon edge along the fides, but none at the internal ends of the divifions. Thefe divifions, including the earth, were covered near two thirds of their length with the fmall round ftones of the fence, and were not continued all round, but were deficient along the fouth-eaft fide, and a little at the fouth corner. Upon digging up the furface in the middle, which was done at my defire, a triangular pavement of flat ftones fet upon edge, was difcovered, about eight inches below the prefent furface, and neareft the fouth-weft corner, as reprefented at E in the ground plan. Small pieces of charred wood, and fome earth around the fides, of a fatter nature than ufual, were got, that in part helped to fill up the ditch that went round the whole infide of the

F f fence,

* The ends of the comburator, as reprefented in Fig. 3, are rather too much extended towards the pavement, and which is therefore of lefs extent than it ought to have been.

fence, and which muft have been intended to preferve the fepulture from being affected with moifture. It may not be improper to remark, that the earth feemed to have retained its original height from the eaft fide of the triangle to near the eaft corner, where there appeared fomething like the remains of a hearth, in a circular form, but which could not be with certainty afcertained; as many of the ftones had been carried away at a former period from that part. See F on the ground plan.

Since my refolution to publifh an account of the above, I have been informed of feveral inclofures in this country of a fimilar nature, particularly one about four miles fouth-eaft of Dumfries, in the parifh of Caerlaverock, and two more between Drumlener g and Sanquhar, at no great diftance from the river Nith. The firft I examined lately. It is fituated in the midft of a piece of ground of the fame height for a mile all round, except on the north-eaft fide, where there is a declivity down to Locher Mofs. It is a fence of the fame nature and breadth with that above defcribed, only a little more of earth mixed through the round ftones: it encompaffes a portion of ground that is at prefent ploughed up, of an exact elliptical figure, the largeft diameter being an hundred and fifty-fix feet by an hundred and twenty-fix broad, with two branches in the enclofure, one on the north-eaft, which feems to have been the chief entrance, and another fmaller on the fouth-eaft end. There is a continued

equal

equal depreſſion of the ground towards the centre all round, ſo that it is hollowed like the palm of the hand: exactly in the middle there is a channelly piece of ground, where the corn and graſs ſeem to fail, and which in all probabiliry was the hearth; ſo that in moſt reſpects it is very ſimilar to that firſt deſcribed, only is a more perfect ellipſe, is a little larger, and its largeſt diameter ſtands in exactly the oppoſite direction to the firſt.

A number of iron chains, hoops, &c were diſcovered on ploughing the field on the north-eaſt, where the declivity is continued down from the cemetery to the moſs, and at no great diſtance from what appears to have been the principal entrance; they were concealed in a niche ſurrounded by flat ſtones, and covered over with them at the top; it was about three feet ſquare, and no great depth below the ſurface. Theſe iron inſtruments were diſcovered about four or five years ago, and were all depoſited with Mr. Riddell, of Glenriddell, except a quantity of the links of the chains, that ſeemed totally deſtroyed by ruſt, and part of the hoops; theſe were not at all like what are intended to ſurround caſks, but their greateſt breadth being from the inner to the external ſide, appeared evidently intended to ſupport a great weight; or rather being in that way capable to withſtand more completely the action of fire. Three complete ones, with the fragments of two or three more, are ſtill in Mr. Riddell's poſſeſſion, together with the greateſt part of the chains

 and

and ſupports. He fortunately got a drawing made of them by the late Mr. Groſe, ſoon after they came into his poſſeſſion; now they are moſtly mouldered away from expoſure to the air, owing to their having been very much corroded by ruſt. With his permiſſion I have got an exact copy taken from his, which is herewith ſent; ſee the Figs. from 5th. to 15th. incluſive; they are of the ſame colour with what the chains, &c. were, when firſt diſcovered. They are of exactly the ſame ſize with Mr. Riddell's drawings, and are therefore on too large a ſcale in proportion to the others. The original large pillared ſupport is about two feet long; each link of the chains extends about three inches and a half, and the others are in the proportion to theſe as repreſented. Beſides theſe articles, the fork, and the hoops, there were three or four ſpades or ſhovels, of that kind formerly uſed in this country, having their edges only ſhoed with iron; the whole of their wood was moſtly decayed. The uſe of theſe articles ſeemed to elude the ingenuity of every perſon that ſaw them, for ſeveral years, till the diſcovery lately of the triangle, hearth, cemetery, &c. makes every thing plain, ſo that now the complete apparatus ſeems to have been diſcovered for the purpoſe of conſuming the dead by fire, and of depoſiting their bones and aſhes thereafter. And what makes it ſtill more remarkable is, the great diſtance of time that they have been preſerved

undeſtroyed,

undeſtroyed, amounting perhaps to ſeven or eight hundred years.

The triangular ſpace E, Fig 4th. appears to have been the hearth upon which the dead of the neighbourbood had been at one period burnt, by the fuel being built or heaped around the *comburator* and corpſe in a triangular form, which it appears they had been very anxious to aſcertain exactly, by having a ſpace conſiderably larger than the comburator ſtood upon, marked out by the ſtone pavement,* ſo as to anſwer as a proper direction during that part of the ceremony. The corpſe muſt either have been ſuſpended by the head and ſhoulders, by means of the hoops and chains, ſo as to be in an erect poſture, or muſt have been in the horizontal poſture, as repreſented at Fig. 3d. The chains were moſt ingeniouſly contrived ſo as to allow of complete flexure in every direction, and to be ſhortened and lengthened at pleaſure; ſee the Figs. of a link in different directions; Fig. 7th. Fig. 8th. and Fig. 9th. One of them could be with perfect eaſe added to or ſubtracted from the uppermoſt end, and ſtill the laſt anſwered as a perfect hook or ring to hang the reſt of the chain and the corpſe by, which could be done, even at the time of the combuſtion, by

* N. B. The ground plan, hearth, &c. having not been laid down geometrically, but only by the eye, ſo as to convey only an idea of the real ſituation of the different parts, the exact proportion is by no means preſerved in the drawings.

by means of the iron fork, Fig. 5th. hooking and unhooking them. This fork might alfo have been ufed to throw any of the fuel, or any part of the body that might not be properly expofed to the action of the fire, into it again; and after any fuch parts had feparated from the trunk, they might have been by that means laid hold of, and being fecured by the chains or bent pieces of iron, reprefented at the bottom of Figs. 10th. and 11th. or ftuck upon the points of the double hook, Fig. 10th. and then fufpended by the ring, at its top, upon one of the large hooks at the bottom or top of the large fupport, Fig. 14th. fo as to be completely confumed; and laftly, the fork might have been ufed for turning the whole corpfe round, by making it revolve upon the pin at the bottom of the ring. See D, Fig. 14th. In the fame manner we may fuppofe, when the head dropped off, which it would almoft always do before it was completely confumed, it might have been fupported in the iron ring, Fig. 15th. which feems to have had another fupport, oppofite to the one by which it is at prefent fufpended, and which in all probability was either hooked on at A, or at B, and which, by means of the two upper hooks C, and D, could be hung upon one or two of the hooks at the bottom or top of the fupport, Fig. 14th.

Figs. 6th. and 15th. feem part of one and the fame inftrument, for confuming the bodies of children, or thofe who were not heavy, by the three hooks

hooks belonging to the three different branches, being introduced into three or more iron hoops that might have been put round the neck of the corpſe; the middle of the body, and the middle of the thighs.* The ſhovels, that were found, may have been uſed for depoſiting the bones and aſhes intermixed with earth, along the inſide of the fence belonging to the cemetery, as already explained. It may alſo with probability be ſuppoſed, that according as the bones were more or leſs conſumed, the niche in which they were depoſited would be made larger or leſs, ſo as to contain them pretty accurately, which will account for their variety of ſize and ſhape, both in the cairns and cemeteries.

There is reaſon to believe, that wood only would be uſed for conſuming the dead, and wherever any diſtrict became well inhabited, the wood would ſoon become ſcarce, from its uſe for that and other purpoſes; and therefore it would become neceſſary to fall on ſuch means as above deſcribed, to prevent the neceſſity of ſo great a conſumption of it as would otherwiſe take place.

The Diſtrict in which the firſt deſcribed Cemetery is ſituated, was then probably well inhabited, for it is at no great diſtance from Knaer Caſtle, that is ſaid

* N. B. Of the three hoops that continue perfect in their circumference, one is ſixteen inches diameter, one eighteen, and one twenty. There are alſo the remains of one or two ſtill larger.

faid to have been the feat of the independent Sovereigns of Galloway, which afterwards fell into the poffeffion of the Baliols, Cummings, Douglaffes, &c. It is upon the weftern banks of the Urr, about three miles fouth-eaft, and at half that diftance between, is fituated a very fine moat, perhaps the moft perfect and largeft in this part of the kingdom, from whence juftice had been difpenfed (fub fole) by the Reguli or their Deputies: it is called *Moat* of *Urr*.

The dependents and people would endeavour to be as near to their Chief's refidence as poffible, efpecially where the foil might be eafily cultivated, as this Diftrict has always been.

We have certainly much reafon to admire the ingenuity of our predeceffors, in making ufe of a very fimple machine (viz. the iron triangle) that would moft effectually fupport their deceafed friend, either in an erect pofture, when flung by the head and fhoulders, as if he had been ftanding as ufual on the ground, and afford an opportunity to all his acquaintances of feeing him in the moft proper pofture for taking an interefting farewell. Or the corpfe might be fufpended in an horizontal pofture, by means of the hoops, and thofe very ingenious chains and fupports, in order to its being moft completely expofed to the action of the fire where ftrongeft, viz. from two to three feet from the ground; fee Fig. 3d. fo as the fire could act

with

with ſufficient force to conſume it, with as little expence of fuel as poſſible.

Perhaps the triangular inſtrument, conſiſting of three equal parts, every way alike, and which could form only one complete ſupport when joined, might have a reference to the doctrine of the Trinity, and thereby teſtify the deceaſed's firm belief of that point, and his hopes of ſalvation through that ſource.*

I think there can be but little doubt, but that the diviſions on the inſide of the fence, marked out by the lines C C C, &c. were diſtinct ſepultures of the bones, aſhes, and remains of different people in the earth, inſtead of depoſiting them entirely amongſt ſtones elevated above its ſurface, as in cairns; and if each diviſion was appropriated to a ſingle family, then this muſt have been the common cemetery of a conſiderable extent of country around.

This mode of ſepulture can be beſt accounted for, from the inhabitants, after converſion, laying aſide the oſtentatious manner of burying their dead, on the higheſt and moſt conſpicuous places, and

 from

* That the doctrine of the Trinity was ſoon canvaſſed in this country, is rendered probable from a tradition, that when St. Patrick wiſhed to give the then uncultivated people of Ireland, and this country, an idea of it, he preſented them with what grew every where under his feet, viz. a leaf of trefoil, or clover.

from an imitation of their neighbours, in committing the laſt remains of their friends to the earth, a little only under the ſurface; whilſt they nevertheleſs retained, what was a favourite cuſtom perhaps, that of cauſing the more corruptible parts to be diſperſed in the air, and aſcend towards heaven, by means of fire. And in the ſame manner they retained their mode of forming niches, or diviſions, between the remains of different bodies, and of diſpoſing of the ſtones nearly as they had been accuſtomed to do, in forming the tumuli, or cairns.

METEOROLOGICAL OBSERVATIONS *made on different Parts of the* WESTERN COAST *of* GREAT BRITAIN: *arranged by* T. GARNETT, M. D. *Phyſician at Harrogate.*

[READ MARCH. 8, 1793.]

THE greateſt part of the materials of which this memoir is compoſed, was put into my hands by my reſpected friend Dr. Percival: they had been communicated to him by ſeveral of his correſpondents, but bad health, and a multiplicity of

of engagements, rendered it impoſſible for him to pay that attention to them, which he conceived they deſerved: he therefore requeſted that I would arrange them, ſo as to form a Memoir for the Literary and Philoſophical Society. This I have attempted to do, but muſt lament with the Society, that they want the uſeful obſervations and remarks, which they would have received from our worthy Preſident. But though this is to be regretted, I truſt that the facts will be deemed important, and that ſeveral uſeful deductions may be drawn from them. They belong principally to a part of the weſtern coaſt of this iſland, ſituated between Dumfries and Lancaſter; this part of the natural hiſtory of which, has hitherto been but little known. It is much to be wiſhed, that the peculiarities of the climate in various parts of this iſland, were aſcertained by ſimilar obſervations, which would be an addition to its natural-hiſtory, not merely gratifying to curioſity, but applicable to the moſt uſeful purpoſes.

The remarks of Mr. Copland, of Dumfries, are very valuable; they are the reſult of attentive obſervation, aſſiſted by a truly philoſophic mind; and though ſome of the theories are perhaps not perfectly ſatisfactory, yet moſt of them are highly probable, and many perfectly new; upon the whole, his remarks contain the beſt and moſt rational rules for judging of the weather, that we poſſeſs. Whether or not they are all applicable to

every part of this iſland, ſimilar obſervations made in different parts can only determine.

From the following obſervations it will be evident, that the quantities of rain are very different in different places; and though in the ſouthern parts of the kingdom, much leſs rain falls than in the northern, yet it appears that this is not in proportion to the latitude of the place, but depends moſt probably on local circumſtances. The annual mean, or average height of the rain which falls at Dumfries, deduced from the obſervations of ſeven years, is 34,658; the quantity which falls at Lancaſter, calculated from obſervations made in the ſame years, is 40,3; while the average quantity which falls at Kendall, ſituated between theſe two places, deduced from the obſervations of five years, is no leſs than 61,2235.—This difference may probably be owing, at leaſt in a great degree, to the high hills with which Kendal is ſurrounded, which form part of that ridge, not improperly called the Engliſh Apennine, which riſes in the north part of Derbyſhire, and running obliquely, nearly through the middle of the iſland, terminates in the Cheviot hills in Scotland. Theſe hills being in the region of the clouds, ſolicit them effectually to depoſit their moiſture.

Were we poſſeſſed of the mean heights of the barometer in ſeveral parts of this iſland, both on the coaſts and the inland parts, deduced from accurate obſervations, made for a conſiderable number

number of years, we could, with tolerable accuracy, determine the comparative elevation of thofe different places above the level of the fea; fome of which, from their gradual rifing, are very difficult to afcertain, but which it would not only be curious, but highly interefting, to know.

In the 59th. vol. of the Philofophical Tranfactions, fome experiments are related, by which it appears, that more rain is collected by a gage placed on the furface of the earth, than by another fimilar gage placed confiderably higher. Mr. Gough's obfervations confirm this fact, fince the quantity of rain collected by the gage at Kendal, is confiderably greater than the quantity which fell upon Benfon-Knott, fituated 320 yards above the level of the town. This fact has engaged the attention of different philofophers, who have endeavoured to account for it, though in a manner not perfectly fatisfactory. Dr. Percival's theory * is very ingenious, and undoubtedly the circumftances mentioned by him have their fhare in the production of this phenomenon, but Mr. Gough's account appears by much the moft philofophical and fatisfactory. It appears likewife from his obfervations, that this difference is lefs in fummer than in winter, which he accounts for in a very ingenious manner.

I am now endeavouring to collect fimilar obfervations made on the eaftern coaft, and fhould I be fuccefsful,

* See Effays, Medical and Experimental, vol. II. p. 85.

fuccefsful, I fhall prefent them to the Society, previous to the publication of their next volume; in the mean time, I fhall be glad to receive communications from any gentleman, who may have been in the habit of making fuch obfervations, or keeping journals of the weather.

State of the perpendicular height of the Falls of Rain, &c. at Dumfries, during the feven years preceding 1784, in inches and decimal parts. By Mr. Alexander Copland, Surgeon, at Dumfries.

	1777	1778	1779	1780	1781	1782	1783	Total in the fame Months of each Year
	Inches							
January	2,255	2,700	2,566	1,103	1,662	6,288	3,812	20,386
February	3,082	1,538	2,624	3,467	3,411	3,477	4,458	22,057
March	2,976	2,631	0,719	4,923	0,294	4,409	0,822	16,774
April	3,015	1,639	2,664	4,149	1,895	1,384	0,097	14,933
May	1,509	3,856	3,624	3,954	0,749	3,780	2,207	19,619
June	3,540	2,280	2,732	2,569	1,458	3,257	2,931	18,767
July	1,698	3,665	5,217	1,067	2,509	1,804	2,787	18,747
Auguft	3,410	2,663	1,704	1,172	6,545	4,149	3,121	22,764
September	2,478	3,467	8,311	6,613	1,432	5,113	4,493	31,908
October	6,110	6,741	5,624	7,309	0,479	3,900	4,812	34,975
November	3,646	5,500	1,003	3,399	5,121	1,316	3,261	23,246
December	0,940	5,674	4,347	0,307	4,433	2,041	1,193	18,935
Total in each year	34,749	42,354	41,135	40,033	29,988	40,918	33,994	Total Depth 263,171

Average of the annual falls for the feven years, commencing with 1777, is 37,596 inches.

The

The average of falls in each month during fourteen years, commencing with 1777, claſſed according to the ſeaſons.

Spring.		Summer.		Autumn.		Winter.	
February	2,822	May	2,481	Auguſt	3,107	November	3,096
March	2,172	June	3,012	September	4,482	December	3,002
April	1,786	July	3,029	October	4,073	January	3,063
Mean falls in the Spring.	6,780	Mean falls in Summer	8,522	Mean falls in Autumn.	11,662	Mean falls in Winter.	9,161

Depths of rain which fell at Dumfries during the ſeven years following 1783.

1784	1785	1786	1787	1788	1789	1790	Total Height
Inches 27,401	30,673	32,008	38,657	26,423	48,093	39,354	242,609 Inches.

Total

Total depths in correfponding months of the fame years.*

Jan.	Feb.	March	April	May	June
Inches 22,493	17,455	13,630	10,082	15,052	23,412

July	Auguft	Sept.	Oct.	Nov.	Dec.
23,668	20,735	30,844	22,042	20,097	23,099

The annual medium of falls, for the fame feven years, is 34,658, and for the fourteen years, commencing with 1777, 36,127 inches.

Upon an average of the laft feven years, the winds have blown in the following directions at Dumfries.

	North	N.E.	Eaft	S.E.	South	S.W.	Weft	N.W.
Days	36	16	66	21	73	52	77	24

Taking the North and Eaft winds in oppofition to the South and Weft, they will ftand as follows

	Days.		Days.
North - -	36	South - -	73
N. E. - -	16	S. W. - -	52
Eaft - -	66	Weft - -	77
S. E. - -	21	N. W. - -	24
Total of the North eafterly winds.	139	Total of the South wefterly winds.	226

BAROMETER.

* Mr. Copland had given the quantity of rain during thefe feven years, in each month, which fell in a fquare foot,

BAROMETER.

THE Barometer was the higheſt on the fifth day of January, 1789, being on that day 30, 9 inches, and on the 18th. of the ſame month it fell to 28, 05 inches, which was the loweſt height during the preceding fourteen years.

The mean height of the Barometer, when placed about fifty feet above high-water mark, may be ſtated at 29, 85 during the ſummer half year, and from the beginning of September to the end of February, at 29, 75 inches.

THERMOMETER.

THE Thermometer was higheſt in the month of June, 1785, when it ſtood for four days running, about three o'clock in the afternoon, at 84°. and on the 26th. about the ſame hour, it was at 86°.—It was found to be loweſt in January, 1784, when it ſtood for four following days at 11°. 12°. 14°. 14°. before ſun-riſe, and on the 25th. it fell ſo low as 8°. early in the morning.

H h Average

foot, in pound, ounce, and drachm meaſures; but it was not thought neceſſary to reduce them to heights in inches, as the compariſon may be eaſily carried on from the total depths in correſponding months.

Average, or mean heat during the feven years preceding January, 1791. The time of obfervation being always ten o'clock in the forenoon.

	Average of heat		Average of heat		Average of heat		Average of heat
February March April	$40\frac{1}{4}$ 43 49	May June July	$58\frac{1}{2}$ $63\frac{1}{8}$ $67\frac{1}{8}$	Auguft September October	$65\frac{1}{2}$ $57\frac{1}{4}$ $50\frac{1}{2}$	November December January	$40\frac{1}{2}$ $38\frac{1}{4}$ $34\frac{1}{4}$
Mean heat of the Spring.	$44\frac{1}{12}$	Mean heat of Summer.	$62\frac{7}{8}$	Mean Autumnal heat.	$57\frac{7}{8}$	Mean heat of Winter.	38°.

The medium of heat at Dumfries during the laft feven years, at ten o'clock in the forenoon, is 50°, 8.

Meteorological

Meteorological Obſervations and Remarks on the Weather at Dumfries. *

THERE is reaſon to conclude,

1ſt. That the time when dry or wet weather may be expected throughout the year, is very uncertain in this country.

2d. That when the weather gets into a fixed ſtate, or into particular ſets of being either wet or dry, it does not appear to be diſpoſed to change to the contrary on a ſudden, but takes always ſome time, after the ſigns of fair weather or rainy have occurred, before it totally alters its diſpoſition.

3d. That broken weather generally ends with very conſiderable falls in the internal and higher parts of the country, as the weather moſtly ſettles immediately after a flood in the river Nith.†

4th. That the heavieſt rains, when of long continuance, generally begin with the wind blowing

H h 2 eaſterly,

* Theſe remarks were firſt publiſhed by Mr. Copland in the Dumfries weekly Journal.

† The ſources and great body of the Nith come from a great diſtance, viz. from Ayrſhire and its confines. There is often a great fall of rain at Dumfries, without the Nith being in any, or but a ſmall degree affected by them.

eafterly, when it gradually veers round to the fouth; and that the rain does not then begin to ceafe till the wind has got to the weft, or rather a little to the northward of it.

5th. That it appears neceffary for the cold which the atmofphere has acquired during the winter months of a fevere feafon, to be thrown off, either by precipitations of hail or fnow, or by its exertions upon the furface of the earth during the fpring months, before it can take on a proper heat for fpring or fummer; hence proceed our backward fprings; or if they are early, they are generally rendered abortive by fome fevere blaft or ftorm about the end of the fpring months; and therefore

6th. That fpring and fummer often commence at nearly one and the fame time.

7th. That the coldeft weather generally occurs when the wind is to the weftward of the north, and not to the eaftward of it, as has commonly been imagined.

8th. That however hot the external air may be in the day time, yet it is always temperate enough at night, having never been obferved to elevate the Thermometer higher in this country at midnight than 66°. and feldom even fo high as 60°.

9th. That the eclipfes of the fun and moon generally occur in the midft of good weather.

10th. That great falls and ftormy weather are more apt to take place on the third or fecond days before,

before, or the third, fourth or fifth days after the change and full of the moon, than at the precife time of thefe.

11th. That the difappearing or thorough folution of clouds in the night time, and particularly in winter, is always accompanied with an immediate increafe of cold.

12th. That the formation of clouds or feparation of watery vapour from the air, and the confequent falls of rain, fnow, and hail, abftract the cold from the atmofphere, and precipitate it to the furface of the earth,* which caufes the air to become warmer in the time of, and immediately after falls, than it was before; but when thefe are accompanied with lightning and other phenomena by which the inherent or latent heat is difcharged from the atmofphere, the whole is rendered colder than at firft.

13th. That when the wind blows over a fpace of country drenched with water or covered with fnow; from the great evaporation thereby occafioned, a much greater degree of cold is foon produced: and when it continues to blow in fuch circumftances

* Mr. Copland feems here to fpeak of cold as a pofitive quality, but it accords better with our prefent ideas, to fay, that on the vapours being condenfed into clouds, rain, and fnow, the heat which was chemically combined with them in a latent ftate, and preferved them in their vaporous form, is fet at liberty, and thus caufes an increafe of warmth in the atmofphere.

ſtances for any length of time, though ever ſo moderately or ſlowly, the ſame effect follows; which is the chief reaſon why the air does not always become warmer after precipitations from it.

14th. That the barometer being lower, and continuing ſo longer than what can be accounted for by immediate falls, or ſtormy weather, indicates the approach of very cold weather for the ſeaſon: and alſo, cold weather, though dry, is always accompanied by a low barometer, till near its termination.

15th. That warm weather is always preceded and moſtly accompanied by a high barometer; and the riſing of the barometer in the time of broken or cold weather, is a ſign of the approach of warmer weather: and alſo if the wind is in any of the cold points, a ſudden riſe of the barometer indicates the approach of a ſoutherly wind; which in the winter generally brings rain with it.

16. That ſtreamers *(aurora borealis)* occurring for any length of time, or when very bright, are a ſign that the atmoſphere is undergoing a conſiderable change; and that either the vapours which floated in the ſuperior regions can be no longer ſuſpended by the electrical æther which adheres to them, and are therefore on their deſcent, which cauſes the aurora to be driven upwards to the ſtill finer and higher regions, from the repulſion of the more firm and denſe mediums below; or it is a real decompoſition of the conſtituent parts of the atmoſphere in

in the ſuperior regions, by which means its electricity is ſeparated from the other parts, and by the ſtronger repulſion of the inferior and more condenſed medium, is forced up in that waving lambent appearance we often ſee it.

17th. That ſoon after ſtreamers have been conſiderable, either bodies of clouds are formed, or elſe a greater degree of cold is immediately produced.

18th. That the quicker ſtreamers are in their motion, and the more they appear to be ſouthward of the zenith, the ſooner will a heavy body of clouds be formed, and in all probability a fall of rain, &c. enſue.—When they have been in that way conſiderable, as to extent and duration, the clouds begin to form with a precipitating appearance, generally in twenty-four hours after, and the fall takes place moſtly before the end of thirty-ſix hours.

19th. That when they are of a deep orange or red colour, ſteady in their appearance, and confined to the north or eaſterly parts of the horizon, there is reaſon to expect a wind from the north or eaſterly points, and one or two days of dry weather, though cold for the ſeaſon, before any fall takes place.

20th. That light or pale ſtreamers are a probable ſign of a ſouth or weſterly wind with a quick formation of clouds, &c. and when they appear, or flaſh and quickly diſappear, in all the parts of the hemiſphere, waving quickly with vivid colours, it

is a ſign of ſtrong winds, or of ſhowers accompanied with guſts of wind.

21ſt. That the longer a fall has been indicated by ſtreamers and a low barometer, not accompanied or followed by cold, without its taking place, the heavier and more continued it will be when it once commences.

22d. That thunder is the conſequence of a very ſudden and thorough change or decompoſition taking place in the lower regions of the atmoſphere, and conſequently, that an immediate precipitation or fall will enſue, if the thunder is near, or a ſudden change of the temperature of the air to cold.

23d. That the falling of the barometer may proceed from a decompoſition of the atmoſphere occurring around or near that part of the globe where we are placed, which will occaſion the electricity of the atmoſphere to be repelled upwards in fine lambent portions; or driven downwards or upwards in more compacted balls of fire; or laſtly, to be carried along with the rain, &c. in an imperceptible manner to the ſurface of the earth: the precipitation of the watery parts generally very ſoon takes place, which diminiſhes the real gravity of the atmoſphere, and alſo by the decompoſition of ſome of the more active parts, the air loſes part of that elaſtic and repulſive power which it ſo eminently poſſeſſed, and will therefore preſs with leſs

lefs force on the mercury of the barometer than before, by which means a fall enfues.

24th. That the caufe of the currents of air, or winds, may alfo be this way accounted for: and in very fevere ftorms, where great decompofitions of the atmofphere take place, this is particularly evident, fuch as occur generally in one or more of the Weft India Iflands at one time, a great lofs of real gravity, together with a confiderable diminution of the fpring of the air immediately enfues, hence a current commences, firft in that direction whence the air has moft gravity, or is moft difpofed to undergo fuch a change; but it being foon relieved of its fuperior weight or fpring on that fide, by the decompofition going on as faft as the wind arrives on the ifland, it immediately veers to another point, which then rufhes in moftly with an increafe of force; thus it goes on till it has blown more than half way round the points of the compafs during the continuation of the hurricane. For in this manner thefe Weft India phenomena, as well as the alteration of the wind during heavy rains in this country (fee remark No. 4) can only be properly accounted for.

25th. That the rifing of the barometer may be accounted for by the watery vapour and other conftituent parts of the atmofphere being thoroughly concentrated or combined together in the form of a real mixt, by means of the phlogifton, latent heat, or electricity communicated by the fun, fire on the

furface

furface of the earth, &c. which act here, as on other occafions, like a bond of union among the other diffimilar parts, fo that the air becomes not only more homogeneous, concentrated and heavier, but alfo may be fuppofed more elaftic and repellent, and therefore will communicate a much greater preffure to the barometer.

26th. That when there is not a fufficient quantity of the principle of heat in the air, to form the vapour, &c. into a real mixt (which is chiefly the cafe in winter) the watery vapour enters in a ftate of folution into the air, if it continues fufpended, and by diffolving in it, a greater cold is always produced. (See Remark 11th.)

27th. That when the watery vapour that has been in folution, feparates itfelf from the air again, and floats about in the form of clouds, then the heat that was neceffarily taken up in the folution of the vapour is fet free, and gives a change of fome more warmth to the temperature of the air.. (See Remark 12th.)

28th. That a high barometer may in like manner be faid to indicate heat, and a low one cold, from the prefence or want of a certain portion of heat or electrical fire in the air, which when in a large proportion muft increafe the warmth, folidity, and fpring of the air, efpecially when by its prefence a real mixture takes place. But when there is a deficiency of the principle of heat in the atmofphere, the watery vapour cannot be thoroughly combined,

combined, but only remains in a ſtate of ſolution in the air, and conſequently a greater degree of cold and diminution of the volume, and preſſure or elaſticity of the air, takes place. *

Dumfries, May 1ſt. 1791.

I SHALL now obſerve in addition to what is above ſtated, that after ten years farther experience, and comparing theſe obſervations with the natural occurrences of the weather, I have always found them ſufficiently applicable, ſo far as general rules ought to be taken and admitted, on ſo uncertain a ſubject as the meteorological changes that are conſtantly going on in an iſland like ours: for when a patch of earth is ſituated like it in the midſt of a great expanſe of ſurrounding fluid, whoſe heat is nearly 45°. and at no time above three or four degrees higher or lower than that medium, whenever the atmoſphere on that ſpot requires a heat conſiderably above that ſtandard, it muſt ſoon be reduced to nearly the ſame temparature, by the action of the ſurface of the ſurrounding fluid on the inferior

* The preceding remarks were inſerted in the Dumfries Weekly Journal, publiſhed Sept. 25th. 1781.

ferior portion and furface of the air that is carried to the ifland by every wind.—For the fame reafons the atmofphere comes to be loaded with the exhalations and vapour of this fluid or fea, which arriving with every wind on our ifland, eafily accounts for the uncertainty of our weather and winds, and the frequency of falls.

In explanation of the 7th. and 8th. remarks it may not be improper to obferve, that when the wind blows North by Weft, it muft be loaded with the cold of the neareft frozen continent, viz. Weft Greenland, and at the fame time takes the fweep of another bleak and almoft uninhabited ifland, viz. Iceland, and will therefore bring along with it a greater quantity of frigorific particles than can be abftracted from it in paffing over the intervening fea, and will approach the coafts of Scotland and North of England in a moft bleak and cold temperature. In order to elucidate the 9th. and 10th. remarks, I fhall obferve, that when the Sun and Moon are either exerting their fpheres of attraction in nearly the fame line, or in a directly oppofite fituation, they muft exert their influence in fo uniform a manner upon our atmofphere and other fluids on the furface of this globe, as to keep up a more equal ballance, and give a greater degree of fteadinefs to the atmofphere, and prevent changes from taking place that otherwife muft have occurred. But when the Moon has altered her pofition fo far with refpect to the Sun, that their

attractions

attractions are exerted in oblique directions, the counterpoiſe is then entirely loſt, ſo that changes and conſequent precipitations will readily ſoon follow.—It may not be improper to obſerve, in addition to the preceding remark, that if a fall continues during an eclipſe, or at the time of the change and full of the moon, it ſhows ſuch a great diſpoſition in the atmoſphere to precipitation, as to overcome the ſteadying influence of the Sun and Moon; and therefore a great deal of rain and broken weather may be expected, as I have often hitherto experienced. But in general, even when the weather is diſpoſed to precipitations, it ſettles for twelve hours before, and twenty-four hours after the change and full of the moon.

It may, perhaps, be proper to make the following addition to the firſt part of the 15th. remark, viz. a high barometer is always accompanied by moderate weather as to wind, and is followed in the firſt place by warmer weather than what is the medium of the ſeaſon; 2dly. by fair weather without precipitations; 3dly. by calm or moderate weather as to wind. It is alſo worth remarking, that a ſteady and ſtrong wind blowing ſix hours or more from the ſoutherly points, always drops the barometer, but from the northerly, always raiſes it.

That a real decompoſition, or loſs of ſubſtance in the air, occurs in the time of great falls, appears highly probable, when in addition to the phenomena narrated in remarks 23d. and 24th. it is obſerved,

obferved, that the monfoons on the coafts of Africa and India, appear to be occafioned by the conftant decompofitions, or falls, continuing for feveral months together in the inland and mountainous parts of thefe continents; the air rufhes in currents in all directions to the precipitating fpot, in order to fupply the lofs of the volume, or real quantity of the air, from the decompofition conftantly going on. It may indeed be faid, that the air, by lofing the vapour, lofes only part of its weight, but none of its volume, and, by becoming more light and elaftic, it mounts up to the fuperior regions, and runs back, in a contrary current, to fill up the deficiencies from whence the underloaded portions of the atmofphere came.

In the firft place, this can never be demonftrated, and 2dly. probability is rather againft it; for, in this country, the upper ftrata of clouds feldom go in a contrary direction to the wind below, but only for a few hours, till the inferior portion comes, by the friction and preffure of what is above it, to partake of this new impetus; difcontinuing the direction in which the whole formerly proceeded, it foons follows the fuperior ftrata which always lead the way. Thirdly, in all great precipitations, it uniformly appears, that the current or impetus of the air is conftantly accompanying the fall of the drops to the furface of the earth, and not upwards; fo that a change of its pofition at the time it parts with its watery vapour, fo as to become fuperior, and prefs upon

upon the other parts which are difpofed to undergo that change, feems on that account nearly impoffible.

It may not be improper to obferve, with regard to ftreamers, that their central point, to which they always tend, is not directly in our zenith, but about ten degrees to the fouthward of it; and that it is probable this deviation of the midft of the crown of the Aurora Borealis, may gradually diminifh and difappear as we approach the equator, but will probably increafe the nearer we are to the poles; and, alfo, that every different place may have its own Aurora Borealis, fimilar, though in moft refpects different from that of every other; in the fame manner, that every place from whence the enlightened fide of a precipitating cloud can be properly feen, has its own diftinct rainbow at one and the fame inftant: and, therefore, that there is no occafion for ftreamers to be at fuch a prodigious height in the atmofphere, in order to be feen at once over a whole continent. For if the atmofphere is in exactly the fame ftate of decompofition over all that extent, it will give the fame appearance to obfervers at feveral thoufand miles diftance, at one and the fame time. That ftreamers are often at no great height in the atmofphere, may be concluded from their appearing at times to the obferver, to be between his eye and the tops of very high mountains, as I have more than once noted; and from their being frequently heard to make a hiffing, or

or jerking noife, which followed fo quickly after the corrufcations, that it was impoffible they could have been elevated above two miles in height, and *feemed to correfpond with their being only about one mile*; a remarkable inftance of which occurred on the evening of the 6th. of January laft, when they were audibly heard by many people, as well as myfelf, at the fame inftant, in and near this place.

*Meteorological Remarks in Weftmoreland, by Mr. J. Gough, of Kendal.**

EXPLANATION OF THE TABLE.

THE firft column contains the year and month, the fecond the mean of the Barometer at Kendal, the third and fourth the mean of the Thermometer, and height of the rain at the fame place: the fifth the rain at Waith-Sutton, the fixth that on Benfon-Knot. The feventh expreffeth the ratio of the rain on

* Communicated by Mr. Gough in a letter to Dr. Garnett.

(THESE TABLES ARE TO FACE page 265)

Meteorological Obſervations at Lancaſter, with Remarks on the ſame, By Dr. Campbell, of Lancaſter*.

Perpendicular Height of the Rain that has fallen at LANCASTER, during the laſt ſeven Years, in Inches and Lines; diſtinguiſhing each Month and Year.

	1784		1785		1786		1787		1788		1789		1790		Total in the ſame months of the foregoing years.	
	In	Li	I	L	I	L	I	L	I	L	I	L	I	L		
Jan.	2	8¼	2	6	2	6	1	7½	2	10	4	5	5	11	22	5¾
Feb.	2	3¾	0	6½	1	1	5	0	2	1	4	11	1	2¼	17	1¼
March	2	7½	0	1	0	11	3	7½	1	10	0	8½	0	8	10	4⅔
April	3	0	1	8	0	4½	1	3½	2	7½	4	3¾	1	3½	14	6¼
May	3	0	1	6	1	8	1	4¼	1	1	4	1½	2	1	14	9¼
June	5	9	1	0½	1	10	3	6	2	0½	5	2½	4	0	23	1¼
July	3	0	2	1½	2	9½	7	0	6	5	5	7¼	7	6	34	5¾
Auguſt	5	0	10	4	5	0	7	0	2	0¼	0	5½	3	10½	33	8½
Sept.	2	7	5	6	7	11	2	0	3	7¼	4	1¼	5	5	31	2
Oct.	0	8	5	9	1	6	9	9	2	1½	6	6	2	9	29	0½
Nov.	3	0	4	6	3	0	4	5½	1	9¼	4	1	4	6½	25	4½
Dec.	1	6	1	2	3	8	4	5	0	10½	6	6	7	4	25	5½
Total in each Year	37	1½	36	8½	32	3	51	01-12	29	45-12	51	01-12	46	61-12	Averages nearly	40.3.4-12

During a Thunder Storm in Aug. 1785, there fell at Lancaſter near ſix Inches perpendicular of Rain one Afternoon.

Upon an average of ſeven Years the Winds have blown in the following Directions:

Days.	N. W.	N. E.	N. W.	S.	S. E.	S. W.	E.	W.	Mean Year.
	30	67	26	51	35	92	17	47	

Taking the North and Eaſt Winds, in Oppoſition to the South and Weſt, they ſtand as follows:

North	—	30	South	—	51
N. E.	—	67	S. W.	—	92
S. E.	—	35	N. W.	—	26
Eaſt	—	17	Weſt	—	47
		Days 149			Days 216

Mean Heat at LANCASTER, during the following Years.

	1784		1785		1786		1787		1788		1789		1790	
	2 P. M.	10 P.M.	2 P. M.	10 P.M.	2 P. M.	10 P.M.	2 P. M.	10 P.M.	2 P. M.	10 P.M.	2 P. M.	10 P.M.	2 P. M.	10 P.M.
Jan.	34.	30.	41.19	37.18	38.22	36.18	41.12	39.13	41.8	38.10	36.14	34.17	42.	40.
Feb.	37.19	33.7	36.13	32.7	40.17	37.	48.3	40.16	43.19	35.5	42.4	40.	46.17	43.
March	42.	34.10	38.20	32.18	40.29	34.14	47.9	42.11	41.14	37.	96.18	34.15	46.	41.13
April	48.	40.17	52.16	43.12	54.5	44.4	47.9	46.2	52.	46.	48.10	42.18	47.15	40.6
May	60.19	50.25	60.	50.	55.9	48.6	60.3	50.6	63.	51.16	59.5	52.	59.	50.20
June	62.	53.6	68.8	56.19	68.4	56.23	64.9	52.10	65.	55.7	63.	54.5	62.15	54.
July	64.18	55.24	66.9	57.15	63.3	56.1	66.	55.21	59.	56.	67.	55.	63.6	54.21
Auguſt	62.18	53.22	60.	53.19	63.11	56.23	61.	55.	62.12	55.	68.7	60.	65.12	56.14
Sept.	64.17	55.21	60.8	53.7	56.4	51.4	60.7	52.	59.10	55.	59.	54.23	58.10	51.
October	51.15	44.	49.11	44.18	47.	44.	55.22	47.15	55.6	47.16	50.	46.	56.9	49.
Nov.	45.	40.21	45.17	41.20	37.	37.26	46.20	38,	46.	42.	44.	38.14	46.6	41.
Dec.	35.	31.	39.1	36.15	38.11	36.19	42.22	38.8	35.8	30.19	46.	43.	40.	38.
Mean Heat	50.8	43.7	51.6	44.11	50.6	44.1	53.	46.5	51.10	45.9	51.7	45.5	52.9	46.5

Mean Heat of the ſame Months in the foregoing Years.

	2 P. M	10 P.M
Jan.	39.1	36.4
Feb.	41.3	37.2
March	41.6	36.4
April	50.	43.2
May	59.3	50.3
June	64.5	54.4
July	64.1	56.
Auguſt	63.2	55.5
Sept.	59.4	53.1
October	52.1	46.2
Nov.	45.5	39.5
Dec.	39.2	36.2
Mean Heat	51.8	45.6

Mean Heat of ſeven Years, Noon and Night, 48.7

Higheſt Degree - 82
Loweſt - - 18

DEPTH of RAIN fallen in SALFORD, during the Year 1792.*

	Inches.	Rain or Snow.		Inches.	Rain or Snow.
January	2	19 Days	July	3,75	24 Days
February	2	16	Auguſt	6,25	18
March	2,75	24	September	9	26
April	2,5	16	October	4	17
May	8	26	November	2	12
June	3,5	24	December	9,5	26
	20,75	125		34,5	123
				20,75	125
			Inches	55, ¼	248 Days Rain

Barometer.

Higheſt Feb. 17, 30,25
Loweſt Sept. 21, 28, 8

Farenheit's Thermometer. No Aſpect.

January 19—8m.—19°. Wind. N. E.
April 13 4a.—68. — Eaſt.
April 10 In ſun ſhine 104°.

* Communicated by George Walker, Eſq. to Dr. Percival.

on the Benſon-knott to that at Kendal, the latter being denoted by unity. This column is added becauſe it was not always convenient to examine the upper gage on the laſt day of the month.

Month.	Mean of Barometer.	Mean of Thermometer.	Rain at Kendal.	Rain at W. Sutton.	Rain at Benſon-knott.	Ratio.
1787.						
June	29,87	—	3,6422			
July	29,78	59,00	5,5549			
Auguſt	29,94	58,70	5,4598			
Sept.	29,94	52,20	2,2260			
Oct.	29,63	45,60	8,8750			
Nov.	29,75	37,30	4,5311			
Dec.	29,64	36,20	4,8973			
1788						
Jan.	29,96	37,10	5,8230			
Feb.	29,48	36,70	3,2115			
March	29,58	36,10	3,1640			
April	29,94	45,74	4,1676			
May	29,98	52,30	1,2919			
June	29,93	56,78	2,5497			
July	29,81	56,50	7,7361			
Auguſt	29,838	55,90	3,2919			
Sept.	29,745	52,78	5,6970			
Oct.	30,078	44,60	2,3479			
Nov.	29,977	40,40	3,4286			
Dec.	29,927	30,00	1,0093			
1789						
Jan.	29,581	32,90	6,9036	5,32		
Feb.	29,498	36,93	9,2058	6,77		
March	29,684	33,90	1,1532	0,53		
April	29,640	42,74	4,5294	3,42		
May	29,780	52,90	5,5618	3,84		
June	29,768	56,30	4,2358	3,86		
July	29,750	58,70	5,2164	6,71		
Auguſt	29,996	60,90	1,4856	1,32		
Sept.	29,757	52,70	5,8674	4,64		
Oct.	29,578	45,80	6,4230	6,90		
Nov.	29,610	38,60	6,2496	5,40		
Dec.	29,63	41,50	13,9380	9,25		

Month.	Mean of Barometer.	Mean of Thermometer.	Rain at Kendal.	Rain at Weft Sutton	Rain at Benfon-knott.	Ratio.
1790.						
Jan.	29,915	37,90	6,8424	4,99	—	—
Feb.	30,074	41,60	3,6744	2,04	1,32933	,343
March	30.187	40,43	1,5240	1,05	,8843	,580
April	29,864	41,30	2,2320	1,42	3,0192	1,603
May	29,87	52,50	2,4612	1,92	2,3173	,942
June	29,91	56,70	3,9786	6,10		
July	29,73	55,95	7,6848	7,41		
Auguft	29,82	56,50	6,3450	5,69		
Sept.	29,89	50,70	6,7056	7,50		
Oct.	29,81	47,40	4,8636	4,30		
Nov.	29,75	38,90	5,0142	4,75		
Dec.	29.72	35.80	9.8154	7,10	1,9264	,196
1791.						
Jan.	29,325	37,90	8,0316	6,85	1,4871	,213
Feb.	29,820	37,10	6,2118	4,34	1,8098	,247
March	30,050	41,08	3,4140	2,88	,9428	,276
April	29,700	46 20	4,5852	4,67	2,6520	,545
May	29.936	49.57	4,2006	4,06	1,5282	,363
June	29,890	55.70	3,2562	1,62	1,4668	,440
July	29,740	58,10	6,1944	5,43	3,8664	,616
Auguft	29,960	57,50	4,8342	4,98		
Sept.	30.040	53.80	3,0420	2,27		
Oct.	29,600	45,80	5,1720	4,19		
Nov.	29,55	40,80	6,5822	4,40		
Dec.	29,49	31,56	7,8372	4,48		
1792.						
Jan.	29,59	33,80	3,7614	3,13		
Feb.	29,84	38,95	5,3622	3,97		
March	29,60	40,00	6,4854	4,37		
April	29,789	46,88	10,0295	7,44		
May	29,865	49,50	6,3036	5,77		
June	29,855	55,00	3,6486	2,32		
July	29,792	58,86	5,7102	7,19		

Gage on Benfon-knott deftroyed.

Gage deftroyed.

REMARKS,

REMARKS.

This is a correct table of the abftract of my obfervations, on the meteorology of Weftmorland. The mean height of the Barometer at Kendal, collected from the obfervations of five years, beginning July 1787, is 29,7845. The mean of the thermometer, at the fame place, for five years, beginning July, 1787, is 46,08. The annual mean height of the rain, for an equal period, is 61,2235. It will be neceffary after what has been ftated above, to fay fomething relative to the fituation of the town.

It is placed on the weft fide of a long valley opening to the S. W. Benfon-Knott, on which a rain gage has occafionally been placed, ftands about two miles N. E. of the town, and is the higheft ground in the neighbourhood; its elevation above the river appears to be nearly 320 yards, by barometrical meafurement. The height of the town, above the ocean, is 66 yatds, calculated from the fame principles, that is, from the fame barometrical mean fpecified above; but, in all probability, does not exceed 40 yards; confequently Benfon-Knott, on the latter fuppofition, rifes 360 yards above the fame level. The diftance of the neareft fea does not exceed 30 miles, from which an eftuary called Kent-fands, advances to within five miles of Kendal. It is manifeft from the laft column in the table, that the comparative quantity of rain on the hill, is

lefs in winter than in fummer. The fact is fupported by the experiments of two fucceffive years, both of which were favourable to the inquiry, becaufe little fnow fell in either feafon; but though it would be rafhnefs to maintain that the law is fairly eftablifhed, yet the following circumftances argue ftrongly for the truth of it. The mean height of the thermometer in wet weather, in winter, is nearly 40°. that is 8°. above the freezing point. Now if we allow that the temperature diminifhes half a degree with every 200 feet of elevation, with Mr. Kirwan, the mean height of the point of congelation will be 1066 yards, from which if we fubtract 320, the height of the hill, there remains 746 for the length of the column of air, that affords the rain collected by the upper gage in winter. On the other hand, the mean height of the thermometer in wet weather, in fummer, is about 54°. confequently, the length of the column that fupplies rain to the upper gage in the warmer part of the year, is 2613 yards, and the mean height of the point of congelation is 2933: but the ratio of 1066 to 746, is greater than that of 2933 to 2613; and as no rain can be formed above the point of congelation, it follows from induction, that when the ratio of the columns that fupply the upper and lower gages is leaft, the quantities collected by them will approach the neareft to equality, and the contrary.

This inclination agrees well enough with the remarks in the table, when a proper allowance is

made

made for ſhowers which fall very partially in mountainous countries. In April, 1790, a heavy ſhower fell on the upper gage, while the water received by that in the town was very trifling. This accounts for the ſtrange deviation from the general rule obſervable in the notes for that month.

The annual mean height of the rain at Waith-Sutton, for three years, beginning January 1789, is 54,13; the ratio of which is to that of Kendal, for the ſame time, as 0,82 to 1. If the ratios of the three winter months, December, January, and February, and of the three ſummer months, June, July, and Auguſt be taken, the former will be as 0,71 to 1; and the latter as 1,001 to 1, a phenomenon that cannot be explained clearly from any thing we know at preſent, yet the fact is certain, becauſe the ratios are determined from long periods. Is it that the air is more powerfully ſolicited in winter to depoſit its water, by approaching the hills, than it is in ſummer? The idea is a mere conjecture, but the comparative ſituations of the two places does not afford a better. Waith-Sutton lies about ſeven miles S. W. of Kendal, and about three miles from the eſtuary before mentioned; its height above the high-water mark of the tide, does not exceed five or ſix yards: the country about it being flatter and more open, than it is a few miles farther north.

Tarlton-Knot, about a mile and a half ſouth eaſt of it, is the only hill of note in the neighbourhood; it is a high, barren rock of lime-ſtone.

The

The general conclufions contained in thefe remarks, are eftablifhed on the means of the different obfervations, which is the true way of reafoning on the fubject.

FELLFOOT RAIN GAGE.*

1788.	In. Pts.	1789.	In. Pts.
January	5,80	-	5,71
February	4,06	-	8,59
March	4,34	-	3,38
April	3,95	-	4,11
May	1,25	-	6,25
June	2,96	-	4,93
July	6,77	-	5,92
Auguft	3,24	-	1,38
September	4,44	-	4,18
October	2,61	-	7,77
November	2,15	-	5,18
December	0,49	-	9,12
Total	42,06	Total	66,52

1790.

* Communicated to Dr. Percival by Lord George Cavendifh.

1790.	In. Pts.	1791.	In. Pts.
January	5,61	-	6,83
February	2,56	-	5,13
March	1,38	-	3,21
April	0,93	-	4,76
May	3,78	-	3,73
June	4,50	-	1,29
July	5,75		
August	7,43		
September	6,82		
October	5,37		
November	5,76		
December	8,59		
Total	58,48	Total	

Depth of Rain which fell at Salford, communicated by Mr. Geo. Walker.

1790.	In.	Lines.	1790.	In.	Lines.
January	2	3	July	5	9
February	1	3	August	4	6
March	1	0	September	3	9
April	2	3	October	2	9
May	3	3	November	3	3
June	5	6	December	7	3
	15	6		27	3
				15	9
				42 ¾ Inches.	

I have not received the account for 1791.

J. G.

1792.	Inches.	Rain or Snow.
January	2	19 Days.
February	2	16
March	2,75	24
April	2,5	16
May	8	26
June	3	24
	20,25	125

1792.	Inches.	Rain or Snow.
July	3,75	24 Days.
Auguſt	6,25	18
September	9	26
October	4	17
November	2	12
December	9,5	26
	34,5	123
	20,25	125
Inches	54 $\frac{3}{4}$	248 Days,

Barometer.

Higheſt	Feb. 17th.	30,25
Loweſt	Sep. 21ſt.	28,8

Farenheit's Thermometer, North Aſpect.

Jan. 19,	8	morning,	19°.	wind	N. E.
April 13,	4	P. M,	68		Eaſt.

April 10th. in the Sunſhine 104°.

Meteorological

REMARKS.

From the foregoing tables it appears, that the ſummer months are not only much hotter about London than at Lancaſter; but that the ſpring is conſiderably earlier: the mean heat of the month of March at 2 o'clock in the afternoon in Pall Mall, being, from the obſervations of Dr. Heberden, 50°. whilſt with us, the mean heat of the ſame month, at the ſame hour, is only 41½.

The exceſs of heat about London in the ſummer months, proceeds as much from having leſs rain, as from a more verticle ſun; and accounts for the ripening of fruit ſooner there, and in greater perfection than with us. Were our atmoſphere leſs loaded with moiſture, the heat at Lancaſter would be amply ſufficient for the purpoſe; as the thermometer placed in the ſhade with a northern aſpect, frequently ſtands in fine ſummer days, at from 70 to 80°. But the great quantity of rain which generally falls during the months of July, Auguſt, and September, chills the air, and occaſions our fruit (eſpecially peaches

Fell-Foot (mentioned in the preceding page) lies at the ſouth end of Winandermere, where the lake contracts into a river; the acclivities of the incloſing hills are ſteep, but more ſo on the eaſt ſide.

and nectarines) to ripen late, and with little flavour. So that our climate ftill preferves the character given it by *Tacitus*, in his life of *Agricola: Cœlum crebris imbribus ac nebulis fœdum.*

The fame circumftances operate to the difadvantage both of our hay and corn harvefts; which laft frequently receives effential damage before it can be houfed. It has been an old obfervation in this country, that thofe who get their hay early, generally get it well; and we fee a very good reafon, becaufe upon an average, nearly one third more rain falls in July than in June. This feems to fhew that an attention to the cultivation of the early graffes, might be productive of confiderable advantages, not only by enfuring a larger crop of after grafs, but by having a greater chance of fine weather for getting in the principal crop of hay. *Mr. Curtis*, in his obfervations on Britifh graffes, enumerates and recommends fix kinds of early graffes. The firft four of them feem beft fuited to our purpofe, viz. the *Anthoxanthum odoratum*, *Alopecurus Pratenfis*, *Poa Pratenfis*, and *Poa Trivialis*. His fifth grafs, the *Feftuca Pratenfis*, is the principal grafs in our beft mowing grounds; this he puts down as producing its flowering ftems near London about the middle of June, but it is feldom in that ftate here before the firft week in July, whilft the others are ripe a fortnight or three weeks fooner.

This excefs of rain, however, which operates to the difadvantage of the ripening of corn and fruit, occafions a more conftant verdure in our pafture fields, in the

the fummer, as well as a more copious crop of aftergrafs than they have in the fouthern parts of this ifland; and points out the fuperior excellence of this country for the purpofe of grazing. The natural advantages which it poffeffes in this refpect, have perhaps given rife to that fine breed of horned cattle, for which Lancafhire has always been famed.

The relative wetnefs and drynefs of the different months, appears to be in proportion to the amount of the rain that has fallen in the fame months of the feveral years. I am, however, inclined to think, that upon a longer obfervation the month of Auguft will not average fo much rain; as it now ftands fo high, owing to a thunder fhower in the year 1785, when near fix inches perpendicular fell in the courfe of a few hours. It was by far the heavieft rain I have feen, and its influence was not extended many miles fouth of the town.

Among the papers which I received from Dr. Percival, is a regifter of the wet and fair days for 18 years, beginning with 1769; by Mr. John Poole, of Rhodes, five miles north-eaftward of Manchefter, on the Rochdale road. In this regifter is put down the number of wet and fair days in each month during

the 18 years above-mentioned; but I think it will be fufficient to infert the refult of each year :—

Year.	Days Rain.	Days Fair.
1769	229	136
1770	246	119
1771	205	160
1772	203	163
1773	182	183
1774	192	173
1775	211	154
1776	192	174
1777	203	162
1778	215	150
1779	184	181
1780	173	192
1781	191	174
1782	239	126
1783	182	183
1784	154	212
1785	181	184
1786	198	167

It is evident from this table, that the average for 18 years is $166\frac{5}{18}$ days fair, and $198\frac{8}{9}$ days rain.

After the preceding effay was finifhed, I received the following letter from Mr. Copland, which as it contains

contains ſeveral uſeful and intereſting remarks, I ſhall take the liberty of inſerting here.

Dumfries, Jan. 15, 1793.

SIR,

I was informed by a letter from Dr. Percival about ſix weeks ago, that my meteorological ſtates and remarks, with thoſe of ſeveral others, had been tranſmitted to you for your peruſal and arrangement. I have now had near two years longer time to reflect on them, and have not as yet ſeen reaſon to alter any one of them entirely. No doubt ſome of them may be judged unneceſſary; and the arrangement and dreſs they appear in may be reckoned improper; but it ſhould be remembered that they were originally intended for a newſpaper, and were in no reſpect altered from that order, which I now regret.

There is one, viz. that the barometer is a moſt certain indication of heat and cold, however imperfect it may be with reſpect to wet or dry weather, which I believe is my own.

Through the whole of the winter preceding the preſent, I was attentive to the changes and alterations of the weather, and found that not one from cold to moderate weather, and vice verſa took place without its being ſufficiently pre-indicated by a conſpicuous riſe or fall of the barometer; and I believe no winter was more completely varied either in temperature or falls. There was an inſtance of a free thaw with a northerly

northerly wind, and a hard froſt with a ſouth-weſt one, for near twenty-four hours each, which could only be accounted for from the firſt being preceded by a high barometer, and the latter by a low one.

I am now convinced that the altitude of the barmometer, as it recedes from the medium of the month, muſt be followed by certain conſequences, which can be reduced to a matter of calculation, and depended on perhaps with more than moral certainty.

Every remarkable elevation of the barometer, where it is of any duration, is followed by very warm or by dry weather, and moderate as to wind, or by all of them; but *heat* ſeems to have moſt influence and connection; and when it is deficient, the continuance of the other two will be the longer and more remarkable; therefore the calculation muſt be in a compound ratio of the exceſs and deficiency of the heat, and of the dryneſs of the weather in compariſon of the medium of the ſeaſon; and with regard to the want of ſtrong wind, it appears to be intimately connected with the laſt, as they ſhew that no precipitation is going on in any of the neighbouring regions: perhaps a reaſon for this will appear on conſulting my former remarks, No. 24th.—You will therefore find every remarkable ſituation of the barometer which is calculated in the incloſed ſtates, for each month, anſwered by a correſponding abberation from the medium as to temperature, taken together with the greater or leſs quantity of falls; and if it is not fully anſwered

anſwered in the ſame month, it is always ſufficiently attoned for in the one that follows; two inſtances of which may be ſeen in January and February, 1791, and in April and May, 1792.

Some farther extenſions of theſe mediums might be made out in the ſtates, particularly with regard to the thermometer, but my time would ſcarcely permit me to complete the one for the year 1792 in the form you ſee it. I thought it unneceſſary to tranſmit the one for the year 1791 till I could ſend you both, as the year was ſo near a cloſe; you have therefore both incloſed.

I alſo think another remark may be added to thoſe formerly ſent, viz. that where two water-gages are kept, the one higher than the other, where the quantity in the loweſt *very much* exceeds that of the high one, it is a ſign that the fall will be of ſome continuance, but where the quantity in the higheſt is equal to, or even exceeds, in a ſmall degree, the lower one, which is ſometimes the caſe, it is a ſign that the bad weather is over, or nearly ſo, and dry weather for a few days may be expected *.—There is a difference of

* This fact obſerved by Mr. Copland, may be eaſily accounted for, becauſe when the quantity in the lower gage very much exceeds that in the higher one, it ſhews a ſtrong diſpoſition in the whole atmoſphere to depoſit its moiſture, and conſequently bad weather may be expected; but when the quantity in the higher is nearly equal to, or exceeds that in the lower gage, it ſhews the atmoſphere to have been in a ſtate

of fix feet in the altitude of my gages, and they are 12 feet diftant from each other.

I fhall be glad to hear from you when convenient, and am,

Sir,

Your moft obedient and humble Servant,

ALEX. COPLAND.

To Dr. Garnett,
Harrogate.

a ftate of momentary decompofition at a confiderable height above the gages, and not difpofed to a precipitation near the furface of the earth.

Firft.

Firſt. The quantity and correſponding perpendicular height of rain, &c. fallen at Dumfries during the year 1792, as meaſured daily at ten o'Clock by lb. oz. and drachm meaſures.—Secondly. The medium height of the Barometer taken at the ſame time, compared with the medium of each month during the laſt fourteen Years.—Thirdly. The medium height of the Thermometer in each month of 1792, taken and compared in the ſame manner.

1792	Falls in a Water Gage of one Foot Square. Quantity of Rain.			Correſponding height of falls.	Above the Medium.	Below the Medium.	Medium for each Month for 15 preceding years
Months	lb.	ozs.	drs.	Inches.	Inches.	Inches.	Inches.
January	13	13	6	3.1801	.0909		3.0892
February	14	1	1	2.8214		.0172	2.8386
March	21	1	3½	4.2242	2.1973		2.0269
April	20	14	6½	4.196	2.3243		1.8717
May	22	0	3	4.494	2.0543		2.4397
June	13	0	0	2.6068		.3918	2.9986
July	22	2	4	4.4429	1.2660		3.1769
Auguſt	20	9	6	4.1326	.9956		3.1370
September	26	10	2	5.342	1.0583		4.2837
October	23	3	6	4.659	.55		4.1090
November	13	6	6½	2.617		.5937	3.2107
December	23	14	6	4.797	1.7652		3.0318
Total throughout the Year.	236	9	2½	47.5130	11.2992		36.2138

1792	Barometer. Medium of each Month	Above the Medium.	Below the Medium.	Medium in each Month for five years.	Farenheit's Scale Thermometer. Medium in each Month in 1792.	Above the Medium.	Below the Medium.	Medium in each Month for five years.
Months	Inches.	Inches.	Inches.	Inches.	Degrees.	Degrees.	Degrees.	Degrees.
January	29.528	.0488		29.4792	35.956	.137		35.819
February	29.792	.1536		29.6384	41.896	1.3206		40.5754
March	29.475		.2432	29.7182	44.290	.750		43.540
April	29.739	.548		29.6842	52.800	3.694		49.106
May	29.7869	.0052		29.7921	56.5625		1.5827	58.1452
June	29.702		.0822	29.8397	60.439		2.954	63.393
July	29.702		.1262	29.8282	65.226		1.3538	66.5798
Auguſt	29.797		.064	29.861	66.519	1.2161		65.2929
September	29.562		.262	29.824	56.133		2.2714	58.4044
October	29.702	.0244		29.6776	49.903		.2804	50.1834
November	29.82	.2377		29.5823	46.70	5.8084		40.8916
December	29.579	.027		29.552	39.613	2.020		37.593
Total throughout the Year.			.2461		51.3364			50.7960

Amount of the Falls in each Seaſon throughout the Year 1792; compared with the Medium for the preceding fifteen Years during the ſame Seaſons.

	Inches	Above the Medium.	Below the Medium.	Medium for 15 Years.
In Spring the depth of falls was	11.2416	4.4808		6.7608
In Summer	11.5437	3.0037		8.5400
In Harveſt	14.1336	2.5395		11.5941
In the 3 winter months	10.5941	1.2752		9 3189
Throughout the year.	47.5130	11.2992		36.2138

Barometer higheſt Anno 1792, April 30th. it ſtood 30.55, and loweſt January 15th. it was 28.7.—Thermometer higheſt Auguſt the 1ſt. 79°.—Loweſt January 13th. before ſun-riſe, 16°.

Number of Days the Wind has blown from the different principal points throughout the Year 1792.

North	North Eaſt.	Eaſt.	South Eaſt.	South	South Weſt.	Weſt.	North Weſt.
Days.	Days	Days	Days	Days	Days	Days	Days
35½	19	71½	23	95	47	48	27

Taking the North and Eaſterly Winds in Oppoſition to the South and Weſterly in this Year, 1792, compared with the Medium of the eight preceding Years, they will ſtand as follows:—

		Above the Medium	Below the Medium	Medium for years.			Above	Below	Medium.
North	35½		.75	36.25	South	95	21.25		73.75
North Eaſt	19	3.94		15.06	South Weſt	47		5.12	52.12
Eaſt	71½	5.44		66.06	Weſt	48		29.69	77.69
South Eaſt	23	3.79		19.81	North Weſt	27	2.75		24.25
Total	149	12.42		137.18	Total of S. W. Winds	217 149		10.81	227.81

Prevalence of the South-Weſt Winds, 68 Days in 1792.

First. The quantity and correſponding perpendicular height of rain, &c. fallen at Dumfries during the year 1791, as meaſured daily at ten o'Clock by lb. oz. and drachm meaſures.—Secondly. The medium height of the Barometer taken at the ſame time, compared with the medium of each month during the laſt fourteen Years.—Thirdly. The medium height of the Thermometer in each month of 1791, taken and compared in the ſame manner.

[To face Page 272.]

	Falls in a Water Gage of one Foot Square.					Barometer.				Farenheit's Scale Thermometer.			
1791	Quantity of Rain.	Correſponding height of falls.	Above the Medium.	Below the Medium.	Medium for each Month for 14 preceding years	Medium of each Month in 1791.	Above the Medium.	Below the Medium.	Medium for the four preceding years.	Medium in each Month in 1791.	Above the Medium.	Below the Medium.	Medium of the four preceding years.
Months	lb. ozs. drs	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Degrees.	Degrees.	Degrees.	Degrees.
January	17 7 4	3.5028	.4400		3.0628	29.2082		3.388	29.547	40.098	5.348		34.750
February	15 4 0	3.0673	.245		2.8223	29.7922	.1922		29.600	41.0772	.8272		40.250
March	9 8 3	1.9096		.2621	2.1717	29.9712	.3412		29.630	45.702	2.702		43.000
April	15 4 1	3.0602	1.2734		1.7868	29.6613		.0287	29.690	49.530	.530		49.000
May	9 4 6	1.8642		.6166	2.4808	29.8203	.0353		29.785	56.726		1.774	58.500
June	8 0 7	1.6903		1.3225	3.0128	29.8747	.0437		29.831	64.364	1.214		63.150
July	26 2 0	5.2386	2.2092		3.0296	29.6570		.2140	29.8710	64.2991		2.8509	67.150
Auguſt	17 11 5	3.5545	.4474		3.1071	29.8851	.301		29.8550	64.4643		1.0357	65.500
September	7 8 0	1.5039		2.9784	4.4823	30.0120	.235		29.777	61.022	3.272		57.750
October	28 0 0	5.6285	1.5559		4.0726	29.568		.137	29.705	48.917		1.5083	50.500
November	24 0 4	4.8185	1.7226		3.0959	29.4915		.1035	29.605	42.4582	1.9582		40.500
December	17 2 6	3.4433	.3731		3.0024	29.414		.173	29.587	32.966		5.784	38.750
Total throughout the Year.	196 0 6	39.2817	3.1546		36.1271								

Amount of the Falls in each Seaſon throughout the Year 1791; compared with the Medium for the preceding fourteen Years during the ſame Seaſons.

		Above the Medium.	Below the Medium.	Medium for 14 Years.
In Spring the depth of falls was	8.0371	1.2371		6.780
In Summer	8.7931	.2711		8.522
In Harveſt	10.6869		.9731	11.6600
In the 3 winter months	11.7646	2.6015		9.1631
Throughout the year.	39.2817	3.1566		36.1251

Barometer higheſt Anno 1791, March 8th. it ſtood 30.6. and loweſt January 4th. it was 28.45.—Thermometer higheſt June the 6th, 80°.—Loweſt December 11th, at ten at Night, 12°.

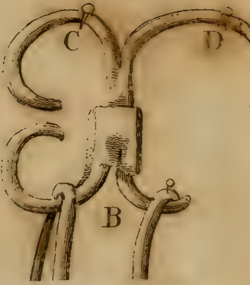
Number of Days the Wind has blown from the different principal points throughout the Year 1791.

North	North Eaſt.	Eaſt.	South Eaſt.	South	South Weſt.	Weſt.	North Weſt.
Days.	Days	Days	Days	Days	Days	Days	Days
38	8½	66½	11½	79	53	82½	26

Taking the North and Eaſterly Winds in Oppoſition to the South and Weſterly in this Year, 1791, and compared with the Medium of the ſeven preceding Years, they will ſtand as follows:—

		Above the Medium	Below the Medium	Medium for 7 years.			Above	Below	Medium.
North	38	2		36	South	79	6		73
North Eaſt	8½		7½	16	South Weſt	53	1		52
Eaſt	66½	½		66	Weſt	82½	5½		77
South Eaſt	11½		9½	21	North Weſt	26	2		24
Total	124½		14½	139	Total of S. W. Winds	240½ 124½	14½		226

Prevalence of the South-Weſt Winds, 116 Days.



ig.


Fig 11th
Fig 12th
Fig 14th
Fig 15th
C
B
A
D
7 Feet 8 Inches
Fig: 2d
Fig: 3d

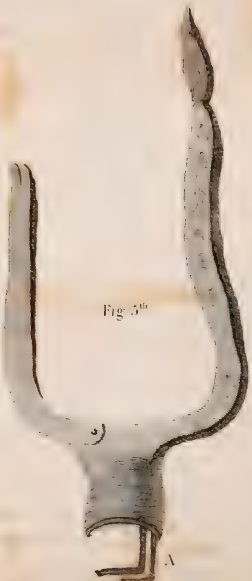


Fig. 5th

Of the same size as here delineated
A *Piece of the Oaken Handle.*

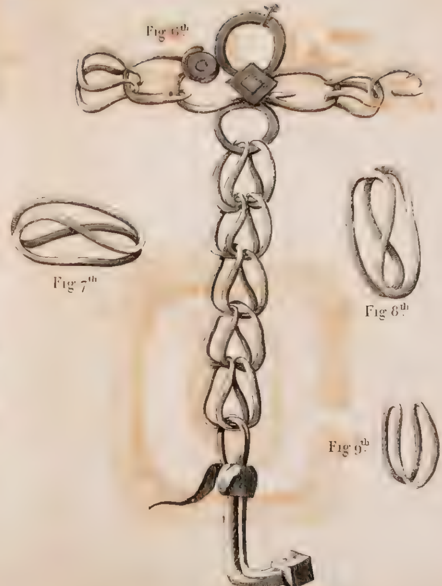


Fig. 6th

Fig. 7th

Fig. 8th

Fig. 9th

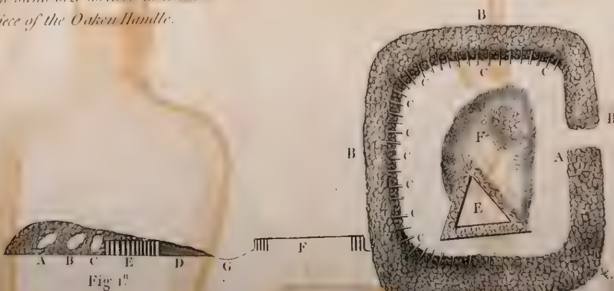


Fig. 1st

Fig. 4th

Neele sculp.t 352 Strand.

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CONTENTS.

EXPERIMENTS

An

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The LAWS *of* MOTION *of a* CYLINDER, *compelled by the repeated Strokes of a* FALLING BLOCK *to penetrate an* OBSTACLE, *the Refiftance of which is an invariable Force. By Mr.* JOHN GOUGH.—*Communicated by Dr.* HOLME.

NO practical benefit is to be expected from the following Effay; for, though the idea is evidently borrowed from the Pile-engine, yet the operations of this Machine are fo much embarraffed by friction and other irregular forces, that it would be abfurd to compare its effects with the conclufions contained in the prefent Paper: the Piece is purely fpeculative, and exhibits a few mathematical truths, which perhaps may afford fome amufement to thofe, who are partial to fuch inquiries.

PROBLEM I. If a Cylinder of hard matter reft with one of its ends upon the horizontal furface of an obftacle, whofe refiftance is a conftant force, it is required to determine by means of the following

 Data,

Data, from what point above the top of the pillar a falling Body ſhall repeatedly deſcend, ſo as to be juſt able to drive it intirely into the obſtacle by a given number of ſtrokes. Data. Weight of the block $= a$, height of the Cylinder $= c$, its ſpecific gravity $= d$, area of its baſe $= e$; laſtly, let it be known from experiment, that if a column of the ſame matter, whoſe height is f, and baſe g, be projected againſt the ſame obſtacle, with the velocity n per ſecond, it will penetrate it to a depth r.

Solution. Let $q =$ the weight of a cubic foot of water, $s = 16\frac{1}{12}$ feet; $y =$ the given number of ſtrokes, and $x =$ the required diſtance; then the weights of the two Cylinders are $= dqce$ and $dqfg$. Now, if a body in motion be reſiſted by a conſtant force, the ſpace deſcribed by it, till its motion is deſtroyed, is as its quantity of matter and the ſquare of its initial velocity directly, and as the reſiſting force inverſely; therefore, when the quantity of matter and velocity are given, the force is as the ſpace deſcribed inverſely; hence the retarding force, which acts on the Cylinder mentioned in the data, is eaſily compared with gravity, ſuppoſing the reſiſtance of the obſtacle to be exerted ſolely on the impinging ſurface of this ſolid; which ſuppoſition is evidently true, when the effects of friction and of the condenſation of the materials in the obſtacle are taken equal nothing, which aſſumption is demanded by the conditions of the Problem, for without it the retarding force cannot be uniform. In

In order to compare this force with gravity, it muſt be remembered, that if a body begin to aſcend with an initial velocity $= n$, it will move through a ſpace $= \frac{n^2}{4s}$; therefore, if the force of gravity be denoted by the weight of the Cylinder, we have as $r : \frac{n^2}{4s} :: dqfg : \frac{dqfgn^2}{4rs} =$ the reſiſtance oppoſed to the motion of the ſolid mentioned in the data, which retarding force is $=$ the reſiſtance of the obſtacle exerted on the ſurface g — the weight of the ſolid, and therefore the whole reſiſtance $= \frac{dqfgn^2}{4rs} + dqfg$. But if equal forces act on different ſurfaces, being uniformly applied to every point of each, the effects produced will be as the ſurfaces, conſequently, as $g : e :: \frac{dqfgn^2}{4rs} + dqfg : \frac{dqfen^2}{4rs} + dqfe =$ the reſiſtance given by the Obſtacle to the Cylinder of the Problem. But the difference of this reſiſtance, and the force ariſing from the ſum of the weights of the Block and Cylinder, expreſſes the retarding force which conſtantly acts on the ſyſtem that penetrates the Obſtacle, and is $= \frac{dqfen^2}{4rs} + dqfe - dqec - a$, which quantity may be called h, and it may be here remarked that h is always affirmative, becauſe

 a negative

a negative retarding force, is an accelerating force acting in a contrary direction. Now the velocity of the Block before the inſtant of impact $=$ $\sqrt{4sx}$, when x $=$ the diſtance deſcended through by the Block in free ſpace, and the velocity of the ſyſtem after impact $= \frac{a\sqrt{4sx}}{a+dqec}$: but if $2s$ be the initial velocity, and gravity the retarding force, s will be the ſpace deſcribed: from this and what has been ſaid above this proportion will be eaſily underſtood, as $\frac{4s^2}{a+qdec} : \frac{4sxa^2}{h\times\overline{a+qdce}^2} :: s;$ $\frac{\overline{a+qdce}\times a^2x}{h\times\overline{a+qdce}^2} = \frac{a^2x}{h\times\overline{a+qdce}}$ $=$ the ſpace penetrated by the ſyſtem after the firſt ſtroke, which is therefore as x, that is, as the height deſcended by the block, and may be put $= tx$ by writing t for $\frac{a^2}{h\times\overline{a+qdce}}$. Then the height deſcended by the block before the ſecond ſtroke $= x\times\overline{1+t}$. Now in this proceſs of penetrating the obſtacle by repeated ſtrokes, the quantity of matter, and the retarding force are given, conſequently the ſpaces penetrated, will be as the ſquares of the initial velocities, that is, as the heights decended through by the block in free ſpace; therefore, as $x : tx ::$ $x\times\overline{1+t} : tx\times\overline{1+t}$ $=$ the ſpace penetrated after

after the ſecond ſtroke. And this quantity being added to $x \times \overline{1+t}$ gives $x \times \overline{1+t}^{2}$, for the diſtance of the required point from the top of the pillar after the ſecond ſtroke. By proceeding in this manner we find the ſucceſſive values of the heights deſcended through by the block before each ſucceeding ſtroke to be $= x,\ x \times \overline{1+t},\ x \times \overline{1+t}^{2}$, $x \times \overline{1+t}^{3}$, continued to $x \times \overline{1+t}^{y-1}$, and thoſe of the ſpaces penetrated by each ſtroke in ſucceſſion, to be $= tx \times 1,\ tx \times \overline{1+t},\ tx \times \overline{1+t}^{2},\ tx \times \overline{1+t}^{3}$ continued to $tx \times \overline{1+t}^{y-1}$. Now it is evident that each rank of quantities exhibited above, conſtitutes a geometrical progreſſion, but the ſum of the latter, which is the ſum of the ſpaces penetrated by all the ſtrokes $= \dfrac{tx \times \overline{1+t}^{y} - tx}{t} = x \times \overline{1+t}^{y} - x = c$ per queſtion, and $x = \dfrac{c}{\overline{1+t}^{y} - 1}$. Q. E. I.

Corollary I. When $y = 1$, $x = \dfrac{c}{1+t-1} = \dfrac{c}{t}$.

Cor. II. Since $x = \dfrac{c}{\overline{1+t}^{y} - 1}$, $\overline{1+t}^{y} = \dfrac{c+x}{x}$, hence it appears that x cannot be aſſumed at pleaſure, but muſt be, according to the conditions

ditions of the Problem, a quantity which will make the expreffion $\frac{\overline{c+x}}{x}$, fome power of $1+t$, whofe index is y, a pofitive integer.

PROBLEM II. All things being fuppofed the fame as in the laft, it is required to determine the time neceffary for compleating the whole operation, on the fuppofition that the block rifes from the top of the column before the firft ftroke, and that the velocity with which it afcends both then and afterwards is uniform, and equal to a given quantity b per fecond.

SOLUTION. The fum of the fpaces defcribed by the block in afcending $= x + x \times \overline{1+t} + x \times \overline{1+t}^{2}$ &c. . . . $x \times \overline{1+t}^{y-1} = \frac{x}{t} \times \overline{1+t}^{y} - 1$; but $x = \frac{c}{\overline{1+t}^{y} - 1}$ by PROB. I. therefore the fum $= \frac{c}{t}$. Now as all thefe fpaces are defcribed by the afcending block with an uniform motion, we have as $b : 1$ fecond $:: \frac{c}{t} : \frac{c}{bt} =$ the time fpent in performing this part of the bufinefs, which does not vary with y or x, but is made up wholly of conftant quantities. From the laws of gravity we get the following expreffion for the time that paffes while the block defcends in free fpace, which is alfo a geometrical

metrical progreſſion $\sqrt{\frac{x}{s}} \times : \sqrt{1} + \sqrt{\overline{1+t}} + \sqrt{\overline{1+t}^{\,2}} + \&c.$ to $\sqrt{\overline{1+t}^{\,y-1}} = \sqrt{\frac{x}{s}} \times \sqrt{\frac{\overline{1+t}^{\,y}-1}{\sqrt{1+t}-1}}.$ When equal quantities of matter in motion, are retarded by conſtant but unequal Forces, the times required to reduce them to a ſtate of reſt are as their initial velocities directly, and as their retarding forces inverſely. Now in the preſent caſe we have the force of gravity $=$ the weight of the ſyſtem $= a + dqce$, and the velocity deſtroyed thereby in 1 ſecond $= 2s$; on the other hand, the reſiſtance oppoſed by the obſtacle to the given column, has been found $= h$, and the initial velocity of the ſyſtem after impact $= \frac{a\sqrt{4s}}{a+qdce}$ drawn into the ſquare roots of the ſpaces deſcribed by the block in its unimpeded deſcent; which ſpaces are ſucceſſively $= x \times 1,\ x \times \overline{1+t},\ x \times \overline{1+t}^{\,2}$ continued to $x \times \overline{1+t}^{\,y-1}$. Hence as $\frac{2s}{a+qdce} : 1$ ſecond $:: \frac{a\sqrt{4sx}}{h \times \overline{a+qdce}} : \frac{a\sqrt{x}}{h\sqrt{s}} =$ the time ſpent in penetrating the Obſtacle after the firſt ſtroke: in the ſame manner it will be found, that the time required for the ſame purpoſe after each ſucceeding ſtroke

ſtroke $= \frac{a}{h\sqrt{s}}$ drawn into the ſquare root of that term of the progreſſion laſt mentioned, which correſponds to the ſtroke, and the ſum of theſe quantities $\frac{a\sqrt{x}}{h\sqrt{s}} \times \frac{\sqrt{\overline{1+t}^{y}-1}}{\sqrt{1+t-1}}$ = the whole time ſpent in penetrating the Obſtacle. Now the ſum of the three parts of time found above = the whole time required for performing the operation $= \frac{c}{bt} +$

$$\frac{\sqrt{x}}{\sqrt{s}} \times \frac{\sqrt{\overline{1+t}^{y}-1}}{\sqrt{1+t-1}} + \frac{a\sqrt{x}}{h\sqrt{s}} \times \frac{\sqrt{\overline{1+t}^{y}-1}}{\sqrt{1+t-1}} =$$

$$\frac{c}{bt} + \frac{a+h}{h\sqrt{s}} \times \sqrt{x} \times \frac{\sqrt{\overline{1+t}^{y}-1}}{\sqrt{1+t-1}} \ldots \quad \textit{Q. E. I.}$$

Cor. I. Now, in this expreſſion for the whole time, the quantities $\frac{c}{bt}$, $\frac{a+h}{h\sqrt{s}}$ and $\sqrt{1+t}-1$, are conſtant, and have nothing to do with the variation of the time, the maximum and minimum of which depend on the variable part $\sqrt{x} \times \sqrt{\overline{1+t}^{y}-1}$; but $x = \frac{c}{\overline{1+t}^{y}-1}$. therefore by ſquaring, we have $x \times \overline{\sqrt{\overline{1+t}^{y}-1}}^{2} = M =$

$\frac{c \times \overline{\sqrt{\overline{1+t}^{y}-1}}^{2}}{\overline{1+t}^{y}-1} = \frac{\sqrt{\overline{1+t}^{y}-1} \times c}{\sqrt{\overline{1+t}^{y}+1}}$. Now, ſince

the

the ratio $\sqrt{\overline{1+t}^{y}-1}$ and $\sqrt{\overline{1+t}^{y}+1}$ conſtantly diminiſhes as y increaſes, it is plain the quotient of the former divided by the latter, or the laſt expreſſion, is a minimum when y is ſuch, that is when $y=1$; on the contrary, the ſaid expreſſion will be a maximum when y is ſuch, that is, when it is infinite. But the time in general is $=\frac{c}{bt}+\frac{a+h}{h\sqrt{s}}\times\sqrt{x}\times\frac{\sqrt{\overline{1+t}^{y}-1}}{\sqrt{1+t-1}}$; but when $y=1$, $x=\frac{c}{t}$ by Prob. I. Cor. I. therefore the minimum of time $=\frac{c}{bt}+\frac{a+h}{h\sqrt{s}}\times\sqrt{\frac{c}{t}}$. In order to find the time a maximum, we have $\overline{1+t}^{y}=\frac{c+x}{x}$ Prob. I. Cor. II. and $\sqrt{\overline{1+t}^{y}}=\frac{\sqrt{c+x}}{x}$, $\sqrt{\overline{1+t}^{y}-1}=\frac{\sqrt{c+x}}{x}-1$, $\sqrt{x}\times\sqrt{\overline{1+t}^{y}-1}=\sqrt{c+x}-\sqrt{x}$.

Now ſuppoſe x infinitely little and y infinitely great, and we have $\sqrt{c}=\sqrt{x}\times\sqrt{\overline{1+t}^{y}-1}$, which, being ſubſtituted for it in the general equation, gives the maximum of time $=\frac{c}{bt}+\frac{a+h}{h\sqrt{s}}\times\frac{\sqrt{c}}{\sqrt{1+t-1}}$, which is therefore finite as well as the minimum.

Cor. II. The Block has hitherto been ſuppoſed to riſe, between every ſtroke, to that

Nn point,

point, to which it aſcended before the firſt: But if, inſtead of this ſuppoſition, we now imagine it to riſe after each ſtroke to the ſame height above the column, to which it aſcended before, the following is the true method of calculating the time, wherein the Block will drive the whole column into the Obſtacle, putting $x =$ the length of its aſcent and deſcent in free ſpace; time of aſcent $= \frac{x}{b}$; time of deſcent in free ſpace $= \sqrt{\frac{x}{s}}$; time ſpent in penetrating the Obſtacle after the firſt ſtroke $= \frac{a}{h\sqrt{s}} \times \sqrt{x}$. Now the ſum of theſe three quantities $= \frac{x}{b} + \frac{a+h}{h\sqrt{s}} \times \sqrt{x} =$ the time ſpent in making one ſtroke; but, as the time is the ſame after every ſtroke, putting y for the number of ſtrokes, we have $\frac{yx}{b} + \overline{a+h} \times \frac{y\sqrt{x}}{h\sqrt{s}} =$ the whole time: Again, the depth penetrated by each ſtroke $= tx$, by what has been found above; and $txy = c$, per queſt. Hence $x = \frac{c}{ty}$ & $\sqrt{x} = \frac{\sqrt{c}}{\sqrt{ty}}$: writing theſe values in the expreſſion $\frac{yx}{b} + \overline{a+h} \times \frac{y\sqrt{x}}{h\sqrt{s}}$, we have $\frac{c}{bt} + \frac{a+h}{h\sqrt{s}} \times \frac{\sqrt{cy}}{t}$ for the whole time.

From

From this it is evident, without further confideration, that when y is a minimum, that is, when $y = 1$, the whole time of performing the procefs $= \frac{c}{bt} + \frac{a+h}{h\sqrt{s}} \times \frac{\sqrt{c}}{t}$ which is the fame with the expreffion for the minimum found in the preceding Corollary, and the value of $x = \frac{c}{t}$ in both cafes. But if x is fuppofed infinitely little, y will be infinitely great, and the time will be infinite alfo; it cannot, therefore, be compared with the minimum as in the former cafe.

Scholium. Though x may be taken infinitely little both in this and the preceding Cor. with the ftricteft propriety, yet it cannot be fuppofed to be *abfolutely* equal nothing, without committing an error in mechanics. Becaufe, while the Block defcends through the leaft fpace imaginable, fome motion will be generated, which will produce a proportionate impreffion on the Obftacle; but, if it actually reft on the top of the column, the fyftem will only act on the plane that fupports it by fimple preffure; and, if its weight be lefs than the force required to overcome the cohefion of the particles which are to be removed, no change will take place. For want of attending to this circumftance, fome who have attempted to folve the Problem contained in the laft Corollary, find $x =$ nothing, when the time is a minimum. The foregoing conclu-

fions

fions are true, when all the retarding forces are neglected in the calculation, excepting the refiftance that is given by the Obftacle to the impinging furface, that is, to that end of the Cylinder which is perpendicular to the line in which the folid moves, and lies contiguous to the refifting matter. If the experiment were carefully made on an Obftacle confifting of homogeneous, yielding matter, the refults of the calculation would perhaps be found to coincide pretty nearly with the refults of the mechanical procefs; but if earth, fand, or other grofs materials are to be penetrated, no fuch coincidence can take place.

In order to form a theory more confiftent with matter of fact, it has been taken for granted, that the column is impeded in its defcent after the ftroke by a variable force, which increafes in the direct ratio of the depth penetrated: But the conclufions that have been drawn from this hypothefis, are not mathematically true, becaufe the calculation from which they are derived, is improperly conducted; for which reafon, the following method is here fubjoined, wherein mechanical principles are more ftrictly attended to.

Problem III. If a Block whofe weight $= o$, fall from a height $= a$, on a Cylinder whofe weight $= m$, and which has already penetrated the Obftacle to a depth $= p$, it is required to determine the fpace penetrated by this ftroke.

Solution.

Solution. Put $s = 16\frac{1}{12}$ feet; $f =$ the variable resistance at the depth p; $g =$ the constant resistance acting on the surface, perpendicular to the line in which the column moves; $x =$ the variable space penetrated: then the weight of the system $= o + m = b$, its initial velocity $= \frac{o\sqrt{4as}}{b} = c$, then the retarding force at the depth $p = g + f - b = h$: and, by the hypothesis, as $p : f :: p + x : f + \frac{fx}{p} =$ the variable resistance at the depth $p + x$, to which adding $g - b$, we have $h + \frac{fx}{p} =$ the retarding force at the same point. Put $c - v =$ the velocity of the system, when $p + x =$ the depth penetrated; then the fluxion of time $= \frac{\dot{x}}{c-v}$, and as 1 second : $2s :: \frac{\dot{x}}{c-v} : \frac{2s\dot{x}}{c-v} =$ velocity destroyed by *gravity* in the time $\frac{\dot{x}}{c-v}$; therefore as $b : h + \frac{fx}{p} :: \frac{2s\dot{x}}{c-v} : \dot{v}$; hence $\overline{c-v} \times \dot{v} = \frac{2s}{b} \times \overline{h\dot{x} + \frac{fx\dot{x}}{p}}$; and by taking the fluent $\overline{c-v}^2 = \frac{2s}{b} \times \overline{2hx + \frac{fx^2}{p}}$. But when $\overline{c-v}^2 = c^2$, $x =$ nothing, and the fluent corrected is $\overline{c-v}^2 = c^2 - \frac{2s}{b} \times \overline{2hx + \frac{fx^2}{p}}$; there-

fore

fore when $c-v=$ nothing, the ſyſtem is reduced to a ſtate of reſt, & $\sqrt{\frac{2s}{b}\times 2hx+\frac{fx^2}{p}}=c^2=\frac{4so^2a}{b^2}$;

which gives $x=\sqrt{\frac{2o^2paf+bp^2h^2}{bf^2}}-\frac{ph}{f}$. Q. E I.

Cor. I. If x and g be determined by experiment, f may be found; for by ſubſtituting, for h in the equation, $\frac{fx^2}{p}+2hx=\frac{bc^2}{2s}=\frac{2ao^2}{b}$, we get $f=\frac{2pao^2-2bpgx+2b^2px}{bx^2+2bpx}$; and, by two experiments, g may be determined; for let A, P, X and F expreſs the ſame quantities in the latter as a, p, x and f do in the former caſe: then $F=\frac{2PAo^2-2bPgX+2b^2PX}{bX^2+2bPX}$; but, by hypotheſis, as $p:P::f:F$; therefore $\frac{2ao^2-2bgx+2b^2x}{bx^2+2bpx}=\frac{2Ao^2-2bgX+2b^2X}{bX^2+2bPX}$; and $g=\frac{X+2P\times x+2p}{2\times x+2p-X+P}\times\frac{2Ao^2+2b^2X}{bX^2+2bPX}-\frac{2ao^2+2b^2x}{bx+2bpx}$.

Cor. II. Hence the truth of the hypotheſis, aſſumed in this Problem, may be eſtabliſhed or refuted: for, if three experiments be made, two values of g may be determined from them; and, as g is ſuppoſed to be a conſtant quantity, theſe values will be

be equal between themſelves, provided the effects of the friction of the column, and the ſurrounding matter increaſe directly as the ſpace penetrated: On the other hand, if the values of g thus found be unequal, it is evident, that the retarding force, occaſioned by the cauſe laſt mentioned, varies in a ratio different from that aſſumed in the hypotheſis. Should any one think of trying this experiment, in order to throw ſome light on the nature of the retarding force ariſing from this kind of impact, it will be proper to uſe a cylinder or right-angled parallelopiped, conſiſting of a hard poliſhed ſubſtance, and containing ſome kind of heavy matter, ſuch as lead, in order to fix the center of gravity of the whole, neareſt the ſurface on which the impact is intended to be made. The inſtrument being thus prepared, ſhould be dropt from different heights on a bed of ſand, which has been previouſly moiſtened, to give it tenacity, and compreſſed by a force ſo applied as to make its denſity uniform, or nearly ſo. This manner of managing the experiment, not only ſimplifies the operation, but renders the expreſſion for g leſs complex; for, ſince the weight of the falling block is the ſame with that of the ſyſtem, o and b are equal; and as the impact is firſt made on the ſurface of the Obſtacle, p and P vaniſh out of the equation: conſequently $g = \frac{b + 4bx}{Xx - X^2} - \frac{abX}{x^2 - xX}$. After all it is highly probable, that the variable part of the retarding force obſerves a ratio which is compounded

pounded of the ratios of the depths penetrated, and of the ſquare of the variable velocity; for, when one body ſlides along another, the friction which continually retards its progreſs, ariſes from the colliſion of the ſmall, but unavoidable, protuberances of the two touching ſurfaces. Now it is evident from the Laws of Motion, that the retarding force occaſioned by the concuſſion of two ſuch protuberances, is directly as the velocity; the number of ſuch concuſſions in a given time is in the ſame ratio; and the number of protuberances acting together is proportional to the touching ſurface of the ſliding body: Conſequently the effect of friction is in a ratio compounded of the touching ſurface and the ſquare of the velocity; that is, in the preſent caſe, as the depth penetrated drawn into the ſaid ſquare.—From theſe conſiderations it is obvious, that the following Queſtion muſt be reſolved before a Theory can be obtained from calculation, which will bear any analogy to the reſult of experiment.

Problem IV. Every thing remaining as in the laſt, excepting the variable part of the retarding force, which is now ſuppoſed to be as the depth penetrated drawn into the ſquare of the velocity, it is required to determine the value of x, when $\overline{c-v}$ vaniſhes.

Solution. Let p, s, g, o, m and x repreſent the ſame quantities as in the laſt Prob. alſo put $f=$ the reſiſtance ariſing from friction at the depth p, with the initial velocity c; then, ſince the friction

is

is as the ſquare of the velocity and ſurface conjointly, we have, as $pc^2 : f :: \overline{p+x} \times \overline{c-v}|^2 : \frac{\overline{pf+fx} \times \overline{c-v}|^2}{pc^2} =$ the variable part of the retarding force; and the whole retarding force $= g-b+\overline{pf+fx} \times \frac{\overline{c-v}|^2}{pc^2}$, & $\dot{v} = \frac{2sh\dot{x}}{c-v.b} + \overline{2spf\dot{x} + 2sfx\dot{x}} \times \frac{c-v}{bpc^2}$, putting $h = g-b$.

Let $\frac{2sh}{b} = r$, $\frac{2sf}{bpc^2} = t$, and by reduction we have $r\dot{x} + t\dot{x} \times \overline{p+x} \times \overline{c-v}|^2 = \overline{c-v} \,.\, \dot{v}$. —— Now becauſe x and v begin together, put $x = Av + Bv^2 + Dv^3 + Ev^4 + Kv^5 +$ &c. where the ſigns and values of A, B, D, E, K, &c. will be determined by the reſolution of a ſubſequent equation, then $\dot{x} = \dot{v} \times : A + 2Bv + 3Dv^2 + 4Ev^3 + 5Kv^4 +$ &c. and ſubſtituting for the values of x and $\dot{x}$ in the Equation $r\dot{x} + t\dot{x} \times \overline{p+x} \times \overline{c-v}|^2 = \overline{c-v} \,.\, \dot{v}$, we get $rA + tpc^2A + \overline{2rB + 2tpc^2B + tc^2A^2 - 2tpcA} \times v + \overline{3rD + 3tpc^2D + 3tc^2AB - 4tpcB - 2tcA^2 + tpA} \times v^2 + \overline{4rE + 4tpc^2E + 4tc^2AD + 2tc^2B^2 - 6tpcD - 6tcAB + 2tpB + tA^2} \times v^3 + \overline{5rK + 5tpc^2K + 4tc^2AE + 5tc^2BD - 8tpcE - 8tcAD - 4tcB^2 + 3tpD + 3tAB} \times v^4 = c - v$. From this expreſſion, the values of the co-efficients A, B,

 D, E, K,

D, E, K, may be found by the common rule: for $\overline{r+tpc^2} \times A = c$, and $A = \frac{c}{r+tpc^2} = \frac{c}{m}$, and $2mB + tc^2A^2 - 2tpcA = -1$, or $2mB = 2tpcA - tc^2A^2 - 1$, and $B = \frac{2tpcA - tc^2A^2 - 1}{2m}$ $= \frac{2tpmc^2 - tc^4 - m^2}{2m^3}$; alfo $3mD + 3tc^2AB - 4tpcB - 2tA^2 + tpA = 0$, and $D = \frac{8t^2p^2mc^3 - 10t^2pc^5 - 4tpm^2c + 7tmc^3 + 3t^2c^5}{6m^4}$ $- \frac{2tm^2c}{6m^4}$. In the fame manner may the values of E, K, &c. be found; therefore, putting $v = c$, $x = Ac + Bc^2 + Dc^3 + Ec^4 + Kc^5 +$ &c.

SCHOLIUM. The difficulty of deriving any practical benefit in the prefent cafe from calculation, will appear from what has been done in the laft Problem; for, after different values of x have been determined by experiment, and as many laborious calculations of the co-efficients of the fucceffive powers of v in the Algebraic expreffion for the fame quantity have been made, the values of f and g ftill remain to be afcertained by reverfing the fame feries and others arifing from it.

SKETCH *of the* HISTORY *of* SUGAR, *in the early Times, and through the Middle Ages.* *By* W. FALCONER, *M.D. F.R.S. &c. &c.* *Communicated by* DR. PERCIVAL.

READ

THE uſe of Sugar is probably of high, though not remote antiquity, as no mention of it is made, as far as I can find, in the ſacred Writings of the old Teſtament.* The Conqueſts of Alexander ſeem to have opened the diſcovery of it to the weſtern parts of the world.

Nearchus,[1] his admiral, found the Sugar Cane in the Eaſt Indies, as appears from his account of it,

* Since writing the above, I have obſerved that the *ſweet Cane* is mentioned in two places of Scripture, and in both as an article of merchandize. It does not ſeem to have been the produce of Judea, as it is ſpoken of as coming from a far country. *Iſaiah*, chap. xliii. v. 24. *Jeremiah*, chap. vi. v. 20.—It is worthy of remark, that the word SACHÀR ſignifies, in the Hebrew language, *inebriation*, which makes it probable, that the juice of the cane had been early uſed for making ſome fermented liquor.

[1] Ante Chriſt. Ann. 325.

it, quoted by Strabo.† It is not, however, clear, from what he ſays, that any art was uſed in bringing the juice of the cane to the conſiſtence of ſugar.

Theophraſtus,[1] who lived not long after, ſeems to have had ſome knowledge of ſugar, at leaſt of the cane from which it is prepared. In enumerating the different kinds of honey, he mentions one that is found in reeds,‡ which muſt have been meant of ſome of thoſe kinds which produce ſugar.

Eratoſthenes,[2] alſo, is quoted by Strabo,* as ſpeaking of the roots of large reeds found in India, which were ſweet to the taſte both when raw and when boiled.

The next author, in point of time, that makes mention of ſugar, is Varro,[3] who, in a fragment

quoted

† Ειρηκε δε περι των καλαμων οτι ποιουσι μελι, μελισσων μη ουσων. Straboni L. xv.

‡ Αλλη δε εν τοις καλαμοις. Fragment of Theophraſtus preſerved in Photius. See p. 864. Edit. Augſburg, 1601.

* Και τας ριζας των Φυτων, και μαλιστα των μεγαλων καλαμων, γλυκειας και Φυσει και εψησει. Strabon. L. xv.

[1] A. C. 303. [2] A. C. 223. [3] A. C. 68.

quoted by Iſidorus, † evidently alludes to this ſubſtance. He deſcribes it as a fluid, preſſed out from reeds of a large ſize; which was ſweeter than honey.

Dioſcorides,‡ [1] ſpeaking of the different kinds of honey, ſays, that "there is a kind of it, in a "concrete ſtate, called *Saccharon*, which is found "in reeds in India and Arabia Felix. This, he "adds, has the appearance of ſalt; and, like that, "is brittle when chewed. It is beneficial to the "bowels and ſtomach, if taken diſſolved in water; "and is alſo uſeful in diſeaſes of the bladder and "kidneys. Being ſprinkled on the eye, it removes "thoſe ſubſtances that obſcure the ſight." The above is the firſt account I have ſeen of the medicinal virtues of ſugar.

Galen[2] appears to have been well acquainted with ſugar, which he deſcribes, nearly as Dioſcorides,

† Indica nam magna nimis arbore creſcit harundo;
Illius e lentis premitur radicibus humor,
Dulcia cui nequeant ſucco contendere mella.

Isidor. lib. xvii. cap. 7.

‡ Eſt et aliud concreti mellis genus, quod *Saccharon* nominatur. In Indiâ vero et felici Arabiâ, in harundinibus invenitur. Salis modo coactum eſt; dentibus, ut ſal, fragile; alvo idoneum et ſtomacho utile, ſi aqua dilutum bibatur; vexatæ veſicæ, renibusque auxiliatur. Illitum ea diſcutit, quæ tenebras oculorum pupillis offundunt. *Matthioli Dioſc.* Cap. lxxv.

[1] A. C. 35. [2] Anno. Poſt. Chriſt. nat. 143.

rides had done, as a kind of honey, called *Sacchar*, that came from India and Arabia Felix, and concreted in reeds. He deſcribes it as leſs ſweet than honey, but of ſimilar qualities, as detergent, deſiccative, and digerent. He remarks a difference, however, in that ſugar is not like honey injurious to the ſtomach, or productive of thirſt.*

If the third book of Galen, "*Upon Medicines that may be eaſily procured*," be genuine, we have reaſon to think ſugar could not be a ſcarce article, as it is there repeatedly preſcribed.

Lucan[1] alludes to ſugar, in his third book, where he ſpeaks of the ſweet juices expreſſed from reeds, which were drank by the people of India.†

Seneca,[2] the philoſopher, likewiſe ſpeaks of an oily ſweet juice in reeds, which probably was ſugar.‡

Pliny[3] was better acquainted with this ſubſtance, which he calls by the name of *Saccaron*; and ſays, that

* De ſimplic. Medicamentis. Lib. vii.

† Quique bibunt tenerâ dulces ab arundine ſuccos,
LUCANI PHARSALIÆ. Lib. iii. lin. 237.

‡ Aiunt inveniri apud Indos mel, in Arundinum foliis, quod aut ros illius cœli aut ipſius arundinis humor dulcis et pinguior gignat.
SENEC. *Epiſtol.* L. I. *Epiſt.* lxxxiv.

1 *Lucani mors.* A. D. 65. 2 *Senecæ mors.* A. D. 65.
3 *Plinii mors.* A. D. 77.

that it was brought from Arabia and India, but the beſt from the latter country. He deſcribes it as a kind of honey, obtained from reeds, of a white colour, reſembling gum, and brittle when preſſed by the teeth, and found in pieces of the ſize of a hazel nut. It was uſed in medicine only.†

Salmaſius, in his Plinianæ Exercitationes, ſays, that Pliny relates, upon the authority of Juba the hiſtorian, that ſome reeds grew in the fortunate Iſlands which increaſed to the ſize of trees, and yielded a liquor that was ſweet and agreeable to the palate. This plant he concludes to be the ſugar cane; but I think the paſſage in Pliny ‡ ſcarcely implies ſo much.—Hitherto we have had no account of any artificial preparation of ſugar, by boiling or otherwiſe; but there is a paſſage in Statius[1], that ſeems, if the reading be genuine, to allude to the boiling of ſugar, and is thought to refer immediately thereto by Stephens in his Theſaurus.*

Arrian,

† Saccaron Arabia fert, ſed laudatius India. Eſt autem mel in arundinibus collectum, gummium modo candidum, dentibus fragile, ampliſſimum nucis avellanæ magnitudine, ad medicinæ tantum uſum.

Plin. *Hiſtor. Natural. l.* xii. *cap.* viii.

‡ Plin. *Hiſt. Nat. lib.* VI. *cap.* xxxii.

* Et quas præcoquit Eboſita cannas
Largis gratuitum cadit rapinis.

Stat. Sylv. I. vi. 15.

Haud dubie (inquit Stephanus) cannas intelligit ex quibus

[1] A. D. *circ.* 80.

Arrian,[1] in his Periplus * of the Red Sea, ſpeaks of the honey from reeds, called *Sacchar* (Σαχαρ) as one of the articles of trade between Ariace and Barygaza, two places of the hither India, and ſome of the ports on the Red Sea.

Aelian,[2] in his natural Hiſtory, ſpeaks of a kind of honey, which was preſſed from reeds, that grew among the *Praſii*, a people that lived near the Ganges.

Tertullian [3] alſo ſpeaks of ſugar, in his book *De Iudicio Dei*, as a kind of honey procured from canes.†

Alexander Aphrodiſæus ‡ [4] appears to have been acquainted with ſugar, which was, in his time, regarded as an Indian production. He ſays, "that "what the Indians called ſugar, was a concretion "of

quibus Saccharum exprimitur vel coquitur. Et fortaſſe Cannas pro Sacchare ipſo poſuit. Sed qui Eboſitæ illi, hactenus apud neminem invenimus. Populi fortaſſe ſunt Indiæ, ubi ſaccharum potiſſimum naſcitur. STEPH. *Theſ.* Vox *Canna.* Lectio autem dubia eſt. *Vide Not.* MARKLANDI *in hunc locum.*

* Μελι το καλαμινον το λεγομενον Σαχαρι. Page 150. *Ed. Amſtelod.* 1683, 8vo.

† Mella viridanti confragrant pinguia canna. TERTULLIAN. *de Judicio Dei.*

‡ ALEX. APPRODISÆI, Lib. II. *Probl.* 79.

[1] A. D. 145. [2] A. D. *circ.* 145. [3] A. D. 195. [4] A. D. 212.

" of honey, in reeds, reſembling grains of ſalt, of a " white colour, and brittle, and poſſeſſing a detergent " and purgative power like to honey; and which " being boiled, in the ſame manner as honey, is " rendered leſs purgative, without impairing its nu- " tritive quality."

Paulus Ægineta*[1] ſpeaks of ſugar, as growing, in his time, in Europe, and alſo as brought from Arabia Felix; the latter of which he ſeems to think leſs ſweet than the ſugar produced in Europe, and neither injurious to the ſtomach nor cauſing thirſt, as the European ſugar was apt to do.

Achmet, †[2] a writer, who, according to ſome, lived about the year 830, ſpeaks familiarly of ſugar as common in his time.

Avicenna,‡[3] the Arab phyſician, ſpeaks of ſugar as being a produce of reeds; but it appears he meant the ſugar called Tabaxir or Tabbarzet, as he calls it by that name.

 It

* Paul. Æginetæ Vox Mel. Μελι. P. 632. Medic. Art. princ. Ed. Henrici Stephani, 1567.

† Vide Meurſii Gloſs. Græc. Barb. & Du Cange Gloſs. ad Script med. & inf. Græcitatis.

‡ De Zuccaro. Lib. II. Tract II.
De Melle. Lib. II. Tract II.

[1] A. D. circ. 400. vel ſecundum Friend multo poſterior. Hiſt. Medic.

[2] A. D. 830. [3] A. D. 980. natus.

It does not appear, that any of the above mentioned writers knew of the method of preparing ſugar, by boiling down the juice of the reeds to a conſiſtence. It is alſo thought, the ſugar they had was not procured from the ſugar cane in uſe at preſent, but from another of a larger ſize, called Tabarzet* by Avicenna, which is the *Arundo Arbor* of Caſpar Bauhin, the *Saccar Mambu* of later writers, and the *Arundo Bambos* of Linnæus. This yields a ſweet milky juice, and oftentimes a hard cryſtallized matter, exactly reſembling ſugar, both in taſte and appearance.

The hiſtorians of the Cruſades make the next mention of ſugar of any that have fallen under my obſervation.

The author of the Hiſtoria †[1] Hieroſolymitana ſays, that the Cruſaders found in Syria certain reeds called *Cannameles*, of which it was reported a kind of wild honey was made; but does not ſay that he ſaw any ſo manufactured.

Albertus

* Some of the Writers ſay, that it was ſo called from the name of a place, Σαχαρ Ταβαρζας, *τοπος ουτω καλουμενος εις Συριαν*. *Conſtantinus a Secretis*, MS. quoted from Du Cange Gloſs. Græc. The word *Tabarzet* ſignifies white, and is tranſlated, by Du Cange, Saccar Album. Herbelot ſays, that the Perſians called by that name the hardeſt and moſt refined ſugar. Bibliothéque Orientale, p. 810.

† Pars ſecunda, p. 595.

[1] 1100.

Albertus Agnenſis * relates, that about the ſame period, “ the Cruſaders found ſweet honeyed reeds, “ in great quantity, in the meadows about Tripoli, “ in Syria, which reeds were called *Zucra*. Theſe “ the people (the Cruſaders army) ſucked, and “ were much pleaſed with the ſweet taſte of them, “ with which they could ſcarcely be ſatisfied. This “ plant (the author tells us) is cultivated with great “ labour of the huſbandmen every year. At the “ time of harveſt, they bruiſe it when ripe in “ mortars; and ſet by the ſtrained juice in veſſels, “ till it is concreted in form of ſnow, or of white ſalt. “ This, when ſcraped, they mix with bread, or rub “ it with water, and take it as pottage; and it is to “ them more wholeſome and pleaſing than the honey “ of bees. The people who were engaged in the

* Calamellos ibidem mellitos, per camporum planiciem abundanter repertos, quos vocant *Zucra*, ſuxit populus illorum ſalubri ſucco lætatus; et vix ad ſaturitatem præ dulcedine explere hoc guſtato valebant. Hoc enim genus herbæ, ſummo labore agricolarum, per ſingulos excolitur annos. Deinde, tempore meſſis, maturum mortariolis indigenæ contundunt, ſuccum colatum in vaſis ſuis reponentes, quouſque coagulatus indureſcat, ſub ſpecie nivis vel ſalis albi. Quem raſum cum pane miſcentes, aut cum aquâ terentes, pro pulmento ſumunt; et ſupra favum mellis guſtantibus dulce ac ſalubre eſſe videtur. His ergo calamellis melliti ſaporis, populus in obſidione Albariæ Marræ et Archas multum horrendâ fame vexatus, eſt refocillatus. Geſt. Dei per Francos, p. 270.

1108.

" ſieges of Albaria Marra and Archas, and ſuffered " dreadful hunger, were much refreſhed hereby."

The ſame author,[1] in the account of the reign of Baldwin, mentions eleven camels, laden with ſugar, being taken by the Cruſaders, * ſo that it muſt have been made in conſiderable quantity.

Jacobus de Vitriaco mentions, †[2] that " in " Syria reeds grow that are full of honey, by which " he underſtands a ſweet juice, which by the preſ- " ſure of a ſcrew engine, and concreted by fire, " becomes ſugar." This is the firſt account I have met with of the employment of heat or fire in the making of ſugar.

About the ſame period, ‡[3] Willermus Tyrenſis ſpeaks of ſugar as made in the neighbourhood of Tyre, and ſent from thence to the fartheſt parts of the world.

Marinus Sanutus mentions, §[4] that in the countries ſubject to the Sultan, ſugar was produced in large quantity, and that it likewiſe was made in Cyprus,

* Geſta Dei, p. 353.

† Sunt autem *calamelli*, calami pleni melle ſucco dulciſſimo, ex quo quaſi in torculari compreſſo, et ad ignem condenſato, prius quaſi mel poſthæc quaſi Zuccara efficitur. Geſt. Dei, p. 1075.

‡ Per inſtitores ad ultimas orbis partes deportatur. Geſt. Dei, p. 835.

§ Marin. Sanut. L. I. Part. I. Cap. 2. — in parte ſecundâ Geſt. Dei.

[1] 1110. [2] 1124. [3] 1124. [4] 1306.

Cyprus, Rhodes, Amorea, Marta, Sicily, and other places belonging to the Chriſtians.

Hugo Falcandus, *[1] an author who wrote about the time of the Emperor Frederic Barbaroſſa, ſpeaks of ſugar being in his time produced in great quantity in Sicily. It appears to have been uſed in two ſtates; one wherein the juice was boiled down to the conſiſtence of honey, and another where it was boiled farther, ſo as to form a ſolid body of ſugar.

The foregoing are all the paſſages that have occurred to my reading on this ſubject. They are but few and inconſiderable, but may ſave trouble to others, who are willing to make a deeper enquiry into the hiſtory of this ſubſtance.

Jan. 24, 1790.

* In præfatione ad Libr. de Calamitatibus Siciliæ.

[1] 1170.

The following Paſſage taken from the Viridarium Franciſci Mendozæ, Sacræ & Profanæ Eruditionis. Coloniæ Agrippinæ, 1633, ſeems to point out, though rather obſcurely, the conſtruction and principles of Balloons.

"Vas æreum, plenum aere, aliter demergendum, in ſummâ aquâ ſuſtentatur, cum eâ ſit naturaliter multo gravius; ergo navis lignea, aut cujuſcunque alterius materie in ſumma aeris ſuperficie conſtituta, *et elementari igne repleta*, ſupra aerem ſuſtinebitur, nec prius in ipſo aere ſubmergetur, quam navigii gravitas ſuperet levitatem ignis, quo plenum eſt."

Problema XLVII. *Utrum aer parte aliquâ ſit navigabilis.*

W. F.

Copy of a Letter from Thomas Beddoes, *M. D. Physician, at Bristol Hot Wells, to Mr.* Thomas Henry, *F. R. S. &c.*

READ, NOVEMBER 29, 1793.

Bristol Hot Wells, Oct. 17th. 1793.

DEAR SIR,

I BEG you to communicate, to the Gentlemen of your Society, a fact similar to those related by Mr. Willis.* At the bottom of one of Mr. Reynolds's smelting furnaces, at Ketley, there was found a green, glassy mass, which, after some exposure to the air, partly deliquesced; and, after a somewhat longer exposure, exhibited white efflorescences over its surface. These efflorescences I found to consist of carbonate of soda. Upon adding distilled water to some of the recent mass, and filtering it afterwards, I obtained a limpid solution, which, on the addition of vitriolic acid, yielded a blue precipitate, exactly, as far as I can judge from the description, of the same nature, at least of the same appearance, as some of Mr. Willis's precipitates. The filtered solution, probably, contained a triple salt, consisting of soda (mineral alkali) iron, and some third material. When the vitriolic acid detached the alkali,

* Manchester Memoirs, vol. 4th. part 1st. page 87, &c.

alkali, the two other ingredients ſubſided on account of their inſolubility. What this third material might be, I never inveſtigated.

I am, dear Sir,

Your's with great regard,

THOMAS BEDDOES.

Some OBSERVATIONS *on the* FLINTS *of* CHALK-BEDS, *in a Letter from* THOMAS BEDDOES, *M. D. Phyſician, at Briſtol Hot Wells, to Mr.* THOMAS HENRY, *F. R. S. &c.*

READ, NOVEMBER 29. 1793.

DEAR SIR,

DURING my reſidence at Oxford, I examined with great attention ſome chalk quarries, or pits, in that part of England, eſpecially near Henley upon Thames. I hoped, or rather I wiſhed to meet with appearances, indicating the manner in which the flints theſe beds contain have been formed and diſtributed. But I was totally unable to frame any hypotheſis, ſuch as would comprehend all the phænomena,

phænomena; nor could I acquieſce in any of the various explanations which mineralogical writers have offered. I incloſe the few obſervations I made upon theſe curious bodies, and requeſt that you will lay them before your Society.

I. It is well known that flints occur, for the moſt part, ſtratified. They ſeldom touch one another in the bed, but lie inſulated, like the ſpecimens in the drawer of a cabinet. In almoſt every ſtratum, I believe, nodules alternate with tables, or flat maſſes, varying in thickneſs and extent. I did, however, obſerve flints irregularly diſperſed among the chalk. Suppoſe the floor of a room to be a flinty ſtratum, and the cieling a ſieve, through which chalk is falling; ſuppoſe, at the ſame time, that a by-ſtander toſſes pebbles occaſionally among the deſcending ſand, and you will have an idea of the manner, in which theſe ſolitary maſſes are diſperſed through the chalk.

II. The rough white cruſt, which ſurrounds each flint, and is at firſt ſight ſo naturally miſtaken for adhering chalk, is formed in conſequence of the decay of the external coat of the flint itſelf. It perhaps is the immediate effect of the decompoſition of the water that ſoaks through beds. That it is owing to the decay of the flint, evidently appears from the change that takes place on the freſh face of fragments, broken for the repair of the roads. Theſe fragments, after a ſhort expoſure to the weather, become tarniſhed; by degrees they turn milky

milky or opaleſcent, then white, opake and rough ſuperficially. We often find, that the ſurface of ſmooth bodies grows rough, when it is undergoing any chemical change, as in the familiar inſtance of poliſhed iron ruſting. The acquiſition, or the loſs of ſome conſtituent principle, produces a diſarrangement of the ſuperficial particles. By filling a phial with fragments of flint and water; and then inverting it in water, the cauſe of the change which the ſurface undergoes might be aſcertained: Its progreſs at leaſt would, in all probability, be obſerved.

III. Many nodules are hollow. Theſe contain either a white powder, or a cellular ſpungy ſubſtance, which latter is more uſually the caſe. A few are ſpherical, or nearly ſo; moſt are of an irregular roundiſh or flatted ſhape, with proceſſes perforated by a hole, within which the contained porous matter appears, pointing outwards, and generally protruding as far as the orifice. A ſpecimen in my poſſeſſion might be thus exactly imitated. Take one of thoſe oval phials, into which bent tubes are commonly inſerted, for the purpoſe of obtaining elaſtic fluids by ſolution. Into this phial, put juſt acid and chalk enough to raiſe a foam that ſhall fill it; then conceive the foam to become concrete. In ſome ſpecimens, I have obſerved the ſpungy maſs to protrude beyond the orifice. And it ſeems to me obvious, from inſpection, that the rarefied cellular ſubſtance, the powder, the

perforated proceffes, or *mamillæ*, and the holes through them, muft have been really produced by the extrication of fome elaftic fluid. The few imperforated hollow nodules I have feen, are much more nearly globular than the others. In thefe, what is now the compact femi-tranfparent coat, muft have yielded fo much during the effervefcence, as to afford fpace enough for the whole of the extricated elaftic fluid. When the effervefcence was rapid, or when the air was produced in large quantity, it burft its way out, producing an elongated mamillary procefs; and carrying along with it the effervefcing fubftance within, as far as the orifice or beyond it. In the fpecimens containing powder, the effervefcing matter muft have become concrete, while its parts were difunited by the iffuing air. Something of the fame kind frequently happens to bars of caft iron, ufed as a grate for reverberatory furnaces. I have feveral times feen fuch bars, after having lain for weeks or months in the furnace, converted fuperficially into malleable iron, and within containing a grey powder. In two papers, printed in the Philofophical Tranfactions, I have fhewn, that air is extricated during the converfion of caft into malleable iron. Now, in the bars which are found to contain powder, the application of heat occafions throughout the whole fubftance of the bar, an effort towards the extrication of air. But from fome curious circumftances, defcribed at length in the latter of the two papers above-mentioned, it appears, that the air iffues

iſſues from the iron with very little force, even when the heat is conſiderable. Hence it is extricated from the ſurface only of the bar; and this alone is converted into malleable iron. During this converſion, the ſurface is heaved and ſeparated from the internal parts; and ſome ſpace within is afforded for the extrication of air: And if the bar ſhould be cooled while the particles are diſunited, in conſequence of this extrication, it will be found to contain a powder.

The duſt and aſhes, ejected in ſuch abundance by volcanoes, muſt be produced by very nearly the ſame mechaniſm. Let us ſuppoſe a ſubſtance in fuſion, from which, or from below which, air or ſteam is rapidly and copiouſly evolved—a very common occurrence at the time of an eruption. Theſe elaſtic fluids iſſue with ſuch prodigious violence as to diſſipate the matter in fuſion, and bear it forward, as duſt is elevated by a ſtrong wind. On its arrival in the atmoſphere, or before, it is cooled, becomes concrete, and deſcends like ſnow upon the ground.

IV. The glaſſy texture and fracture of flints, in the firſt place, leads me to believe that they have been fuſed. I have ſometimes, within the hollow ſpecimens, ſeen filaments paſſing acroſs from ſide to ſide—another analogy, as I apprehend the fact, with glaſs; theſe filaments having been drawn out in the manner of ſpun glaſs, as the flint bubble was blown up by elaſtic fluids formed within. In the ſame

light

light I conſider the white opake ſpots, ſo commonly appearing in the ſubſtance of flints.

Mr. Dolomieu (*Journal de Phyſique*, 1792) has related experiments, from which he concludes, that ſiliceous matter in a ſtrong heat yields hydrogene air. His experiments are not indeed perfectly deciſive; becauſe the air might have come from the alkali, with which he fuſed his ſiliceous earth. Should it however come from the flint, the fact would furniſh an explanation of the appearances I have deſcribed. Streaks or weals may ſometimes be obſerved upon the internal ſurface of hollow flints. I have ſeen theſe ſtreaks round, and dilated at their termination. They muſt, I imagine, have been formed by viſcid matter running upon the inſide of the nodule. Exactly the ſame appearance might be produced, by letting flow down the inſide of a tea-cup a liquid, too tenacious to run off the ſide entirely, but thin enough to reach the bottom, and form a ſmall button there. If we could ſuppoſe, with Dr. Hutton, that flints were ſpouted into the body of the chalk from ſubterraneous fires, we might imagine the ſurface of each clot to have been cooled by coming into contact with the chalk, or during its paſſage, while the internal parts continued to boil and bubble, and work themſelves into foam or powder. I cannot however conceive, how the nodules and tables could have been arranged, in the manner they are, by injection.

V. Balls

V. Balls of ochre are ſometimes found in chalk-pits. Theſe balls, on examination, clearly appear to have exiſted in ſome other ſtate ſince their depoſition in the chalk-beds. They contain lumps of matter, much reſembling ferrugineous vitrifications: whence I conjecture, that the whole ball was once in the ſame ſtate.

Long ſince this conjecture was formed, I obſerved in the quarries about Clifton, appearances which ſtrongly confirm it. I have before me brecciated ferrugineous maſſes, and maſſes of friable ochre, each having preciſely the ſame ſtructure. I have even a ſeries of ſpecimens, from the hardeſt, reddiſh, brown ferrugineous breccia, to the moſt friable ochre, in which the angular fragments are ſeen perfectly; and, what ſeems to remove all doubt, you can perceive ſpecks of ochre, beginning to form here and there in the hardeſt of theſe maſſes.—All the compact ferrugineous maſſes, which I have ſeen about Clifton, are varieties of *hæmatites*. I add, as a circumſtace which ſeems to point out the origin of theſe maſſes, that a Gentleman one day laſt ſummer picked up in my preſence, in a quarry between *Glouceſter Row* and the *Mall*, a ſpecimen of *hæmatites*, which has exactly the ſhape of a drop, falling from one contiguous ſurface to another. To that, which may be ſuppoſed the upper ſurface, it is attached by a narrow neck; while the body, a little flattened by reaſon

reafon of its fize and fpecific gravity, refts upon the lower furface.

I am, dear Sir,

With great regard, your's,

THOMAS BEDDOES.

BRISTOL HOT WELLS,
NOV. 1, 1793.

Experiments *and* Observations *on the* Vegetation *of* Seeds. *By* Mr. John Gough.—*Communicated by* Dr. Holme.

READ, FEBRUARY 21, 1794.

EVERY one, at all acquainted with natural hiftory, knows that the feeds of many plants will, after lying in the ground for many years in a ftate of perfect inactivity, fpring up, when the foil is broken, in full vigour, and with a profufion, that fhews the earth to have contained them in great numbers. Reflecting on this curious phænomenon in July 1787, I made the following experiment, with a view to difcover, what are the contingent circumftances, that give life and energy to the vegetative principle in the embryos of plants.

Experiment

Experiment I. Having nearly filled two phials with barley, that had been ſteeped in water for forty-eight hours; I corked one of them ſecurely, and placed it in the dark. The other was buried at the ſame time in a box of light dry mould, its mouth being previouſly covered with a piece of thin cloth, to prevent ſand and other impurities from falling into it. The contents of the latter bottle were found, at the end of three days, in a ſtate of vigorous vegetation; every grain having one ſprout, or more, of a conſiderable length. The grain in the phial which was corked retained its former appearance; but had contracted a ſmell that was diſagreeable, and very different from that which it had when newly taken out of the water.

The only juſt concluſion from the preceding experiment, is, that a given quantity of ſoaked grain, either requires a given quantity of air to make it vegetate, or a free communication with the atmoſphere at large. The philoſophers of the laſt century knew, that the preſence of air is neceſſary to the vegetation of ſeeds, becauſe they remain unanimated *in vacuo*; but, if my memory do not deceive me, they were ignorant of the fact juſt now ſtated. I have, therefore, given it a place in this eſſay, partly becauſe it appeared to be new; and partly becauſe it occaſioned the ſucceeding experiments, which are of a more deciſive nature. But, before I enter on the detail, it may not be improper to

ſay

ſay ſomething on the ſtructure, and the conſtituent principles of vegetables.

A plant is an organized body, conſiſting of fibres, veſſels, and different organs, intended to produce different ſecretions by their ſpecific modes of action: ſuch are the gummy matter of the *Stigmata*, the *Pollen* of the *Antherae*, the honey of the *Nectarium*, and the different vegetable acids commonly contained in the *Pericarpium*.

The ſubſtances enumerated above, though very diſſimilar in their ſenſible qualities, are made up of but a few primary elements, that are combined in various proportions in the reſpective compounds.

Theſe are I. Oxygene, or the baſis of reſpirable gas. II. Hydrogene, or the baſis of inflammable gas. III. Carbone, which when ſeparated from the other two forms charcoal. Water, which is itſelf a compound, enters the abſorbing veſſels of all vegetables; where it ſerves as a vehicle for the unaſſimilated particles, and afterwards eſcapes by perſpiration, either wholly, or in part.

The foregoing matters are found in the compoſition of all vegetables; and Azote, or the baſis of mephitic gas, alſo, contributes to the materials diſcovered in the plants of the claſs Tetradynamia. This ſubſtance unites, during putrefaction, with Hydrogene, and compoſes *volatile Alkali*: a property which is peculiar to the genera of the claſs in queſtion. The parts of a ſeed are, the *Germ*, and the

ſeed

lobes. The former is a fmall bud, that appears to be the receptacle of the vegetative principle, where it lies torpid, till its activity is excited by foreign caufes. The feed lobes are two foft bodies, which, cöhering clofely, leave a notch between them for the reception of the Germ. They confift of a vegetable *oxyd*, or of a bafis compounded of Carbone and Hydrogene, and impregnated with Oxygene: a quantity of oil, or of the bafis not oxydated, is diffufed through their fubftance. When feeds are covered with water, or buried in wet earth, they imbibe a portion of humidity; in confequence of which, the vegetative principle begins to exert itfelf, if not prevented by a want of a proper degree of warmth, or by other caufes. It is highly probable, that no two kinds of feeds abforb equal quantities of water: For, I have found, that barley takes up only one-third of its weight of this fluid in forty-eight hours; but that peas charge themfelves with three-quarters of their weight in the fame time. Having ftated the foregoing facts, which the nature of this effay feemed to demand, I fhall proceed in the detail of my experiments.

Experiment II. One ounce of fteeped barley being put into a bottle which would hold one ounce three drams of rain water; and alfo three drams of the fame grain, prepared in the fame manner, into a fecond bottle capable of containing four ounces of water; they were both clofely corked, and placed

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in a dark room, where the mean height of the thermometer was fifty-eight degrees during the experiment. At the end of four days, the three drams of barley, in the large bottle, had vegetated much; but the greater quantity, in the leſs bottle, had not produced one ſprout. The ſame change in ſmell was however obſerved, which I have noted in the former caſes. Hence it is evident, that a free communication with the atmoſphere is not abſolutely required, to bring the vegetative principle of ſeeds into action. On the other hand, it is equally manifeſt, both from this and the preceding experiment, that a given quantity of grain muſt be placed in a given quantity of air to make it vegetate.*

Experiment III. Since permanently elaſtic fluids eſcape very copiouſly from vegetables, ſubjected to the vinous and putrefactive fermentations, it might be ſuppoſed, that the ſame thing happens with ſeeds in the act of vegetating; and that this diſcharge being ſuppreſſed, for want of room, in the ſmall bottle uſed in the laſt experiment, the expanſion of the Germs was thereby prevented. In order to examine this matter with ſome care, I began with putting ſeveral

* The ſecond and ſucceeding experiments were repeated in the Autumn of this year (1793); when the preſent concluſions, founded on the new theory of chemiſtry, were alſo added.

ſeveral parcels of peas and barley, previouſly ſteeped, into ſmall jars, and then covering them to different depths with water, both clean and foul. The ſeeds, thus treated, ſhewed no ſigns of vegetation, after ſpecimens of the ſame kind, ſtanding near them, in open bottles, had made a conſiderable progreſs. At the time, I attributed this inability to vegetate, to the air being excluded by the incumbent fluids; which ſuppoſition appeared more reaſonable than the contrary opinion, namely, that ſome elaſtic matter was prevented from quitting the ſeeds, by columns of water not exceeding one inch in length, which can only preſs with a very ſlight force.*

Experiment IV. I put three drams of dry peas into a bell-glaſs filled with water; and inverted it in a ſmall veſſel of the ſame fluid. At the end of forty-eight hours the jar remained full, but a quantity of water, taken from the baſon in which it ſtood, rendered lime water turbid; a proof that it contained Carbonic Acid. The ſame experiment was repeated with four drams of barley, and the reſult was nearly the ſame; only the preſence of the Carbonic Acid was not ſo ſtrongly indicated by the teſt of lime water.

Experiment V. Two ounces of water, in which barley had been ſoaked forty-eight hours, were put

 into

* Since this experiment was made, I find it not to be new. *Malpighi* did the ſame thing with the ſame reſult. *Vide Opera ejus.* Tom. I. p. 108.

into a pint bottle; an ounce-phial half filled with lime water, was ſuſpended by a thread in the veſſel, ſo as not to touch the liquor; the bottle was then cloſely ſtopped with a clean cork. The lime was precipitated from the water in the phial at the end of forty-eight hours. Hence we are authorized to infer, that Carbonic Acid Gas had been generated in the bottle during the courſe of the experiment.

Experiment VI. Being by this time convinced, that Carbonic Acid is produced by the vegetation of ſeeds; and believing with Mr. Lavoiſier, that the acid in queſtion conſiſts of Carbone united to Oxgyene, I endeavoured, in the next place, to diſcover whether the atmoſphere or the vegetable oxyds of the materials uſed in my experiment, ſupplied the acidifying principle. For this purpoſe I placed ſeven drams twenty-three grains of ſteeped peas in a new phial, the mouth of which I covered with a piece of clean window glaſs, which was intended to condenſe the vapour, ſhould any aſcend into the neck. The bottle, thus prepared, was ſcreened from the action of the light, ſo as not to prevent the free acceſs of the air to its contents. At the end of one hundred and twenty hours, the peas were found to be vegetating freely, many of them having ſprouts two inches long. The neck of the phial, and the glaſs that covered it, were free from moiſture. The whole was then carefully weighed; and, the neceſſary deductions being made for the bottle and glaſs, the peas were neither more nor leſs than ſeven drams

twenty-

twenty-three grains, their original weight. The mean height of the thermometer, during the courfe of the experiment, was 59, 5°. I made the fame trial, at another time, with a bottle containing one ounce three drams of fteeped barley, and 6, 16 cubic inches of air. Befides ufing the fame precautions obferved in the laft cafe, I frequently changed the air of the phial, by fucking it out through a flender glafs fyphon. At the end of ninety-fix hours, the weight was decreafed 2drs. 5 grs. The lofs of this fmall quantity was probably occafioned by water efcaping through the fyphon, in combination with the Carbonic Acid Gas, and other permanently elaftic fluids. Thus it appears, that the vegetation of feeds caufes very little diminution of their weight, if any at all. On the contrary, the vinous fermentation of vegetable fubftances, is attended with a very fenfible lofs in this refpect. Neverthelefs the Carbonic Acid Gas is generated in both proceffes, and often fo plentifully in the latter, as to burft the veffels containing the fermenting materials, provided a free egrefs be denied it; but no fuch force is obfervable in the former cafe. I therefore found it neceffary to follow a different method, in order to difcover the origin of this gas, during the firft ftage of vegetation.

Experiment VII. Six drams of fteeped barley were put into a bell-glafs, in the upper part of which it was fecured by a muflin ftrainer ftretched on a hoop of whalebone, tightly fitted to the infide

ſide of the bell. Seven ounce meaſures of atmoſpheric air were then introduced into the jar through the water in which it was inverted, care being taken that the height of the water within the glaſs ſhould be on a level with that in the baſon; which point was exactly marked on the outſide. The barometer at the ſame time ſtood at 30, 25 inches; the thermometer at 54, 5°. In the ſpace of eighteen hours the barometer had riſen to 30, 31 inches, the thermometer being at 55, 5°; and the water incloſing the air appeared above the mark. Upon ſhaking the jar, the air contracted, which could only be occaſioned by the abſorption of Carbonic Acid Gas uniting with the agitated water: At the end of ſixty-ſix hours, the grain had ſprouted as much as could be expected in the time. It was judged neceſſary to put an end to the experiment, becauſe the barometer and thermometer ſtood exactly at 30,25 inches, and 54, 5°. The height of the water in the jar was carefully marked in the next place, and the contents of that part of the veſſel, lying between this point and that fixed on at firſt, being accurately aſcertained, it appeared that the air, in contact with the barley, had loſt $\frac{1}{10}$ of its original bulk. The diminution would undoubtedly have been made ſtill greater, by expoſing it to lime water, but I did not purſue the ſubject any farther at that time, being contented for the preſent with determining the vegetative proceſs to differ eſſentially from the vinous fermentation; for the Carbonic Acid

Acid Gas that efcapes from fermenting fubftances, during the converfion of fugar into alcohol, is generated by thofe fubftances themfelves. On the contrary, a part of the furrounding air is either abforbed by feeds in the act of vegetation, or a portion of its Oxygene is charged with Carbone derived from them. But this will be placed in a clearer light by the next experiment.

Experiment VIII. I put feveral parcels of fteeped peas and barley, at different times, into phials, which were left to ftand, for three or four minutes, in fpring water, of the heat of 46, 5°, to reduce them to a known temperature. They were then fecurely corked, and removed into a room, the temperature of which was never lefs than 53°. After remaining from four to fix days in this fituation, they were again placed in the fame fpring water, and opened in an inverted pofition, care being taken that the barometer ftood at the time nearly where it did at firft. When a cork was thus drawn, a quantity of water rufhed in immediately, more than was fufficient to fill the neck. The air being paffed through lime water, contracted very fenfibly, and precipitated the lime. The refiduum, freed in this manner from Carbonic Acid, extinguifhed a lighted taper like water; and this it did repeatedly. I made one of thefe experiments with more attention than the reft, from which it appeared, that four ounces one dram forty grains, by meafure, of atmofpheric air, loft one-fixth of its original bulk, by being

being confined five days, with one ounce of ſteeped barley. Now if the imperfections of my apparatus do not lead me into error, it is plain that ſeeds, in the act of vegetation, take Oxygene from the atmoſphere, part of which they retain, and reject the reſt charged with Carbone. The ſubſtances of the ſeed-lobes is hereby changed, an additional quantity of Oxygene being introduced into their compoſition; and a part of their Carbone loſt. This change, in the proportion of their elementary principles, generates ſugar, as is evident from the proceſs of malting. But Sugar and Carbonic Acid are more ſoluble in water, than the farinaceous Oxyd. They therefore combine with the humidity in the capillary tubes of the ſeed, and find a ready paſſage to the Germ, the vegetative principle of which they call into action by a *ſtimulus* ſuited to its nature. A nutritious liquor being thus prepared, by the decompoſition of the ſeed-lobes, and diſtributed through the infant plant, its organs begin to exert their ſpecific actions, by decompounding the nouriſhment conveyed to them, and forming new Oxyds from the elementary principles of it, for the increaſe of the veſſels and fibres; and in this manner the firſt ſtage of vegetation commences. One principal uſe of the ſeed lobes being aſcertained, we are enabled to underſtand ſome experiments made by Malpighi. This induſtrious philoſopher ſtripped the germs of a great number of beans, and a variety of other ſeeds, of their external coverings, and placed

placed them naked in the ground. Of all that he treated in this manner, only three beans vegetated, not in the ufual way, but very imperfectly: vide *Malpighii opera* Tom. I. p. 109. It is evident then from the experiment of the Italian philofopher, that the juices of the earth, though fit for the nutrition of maturer plants, are infufficient to awake the latent energy of their Germs. But if the feeds be planted in the earth unmutilated, thefe juices are imbibed by their feed lobes, and there receive the impregnation which is neceffary for the vegetative procefs; the atmofpheric air, that contributes fo much to the change in their compofition, having free accefs to the feeds through the pores of the foil, as may be fafely inferred from the firft experiment. It is highly probable, that the Germs of the beans which attempted to vegetate, were not perfectly freed from the farinaceous matter; they therefore fprouted, but withered foon after for want of proper nourifhment.

Experiment IX. Having now difcovered the ufe of Oxygene to plants, in the firft ftages of their growth; I inquired, in the next place, what would be the confequence of inclofing feeds in azote, after faturating them with water. For this purpofe, I put two equal quantities of fteeped barley, viz. one ounce, one dram, thirty grains, into feparate bell-glaffes, where they were fupported by ftrainers, as as in the feventh experiment. One bell was then fet, with its mouth downwards, on a table, a fmall

bottle of lime-water being placed under it. After filling the other with rain-water, and inverting it in a veſſel of the ſame, I introduced into it ſeven and one-fourth ounce-meaſures of air, that had been confined more than a week with putrid fleſh, in a veſſel ſtanding in water. The Barometer was at the time at 29,81 inches; a Thermometer, placed beſide the jars, ſtood at 56°. The lime-water, in the bottle under the firſt glaſs, became turbid in the ſpace of twenty-four hours. At the end of three days, the barley it contained had ſprouted conſiderably, while the parcel in the other jar remained unaltered; nor was the bulk of the Azote confined with it increaſed or diminiſhed perceptibly. The Barometer and Thermometer ſtanding very nearly at the points ſpecified above, when the bell glaſs was agitated in water, the incloſed air did not contract in the leaſt: a proof that no carbonic acid gas was mixed with it. The jar being taken out of the water, and cleared of the gas, was placed on the table, with a bottle half-full of lime water under it. In fourteen hours, part of the lime-water was precipitated; and, in ſeventy-two hours, the grain had ſprouted, juſt as if it had never been expoſed to any thing but atmoſpheric air. I repeated this experiment, at another time, with four drams of ſteeped barley, and two and a half ounce-meaſures of air, being part of the reſiduum of a quantity of common air that had been in contact with a ſolution of liver of ſulphur for eight days. The experiment was con-

tinued

tinued fix days without fhewing the leaft fign of vegetation; but, on admitting common air into the glafs, its contents fprouted freely. This experiment proves decifively, that feeds faturated with moifture have no affinity to Azotic Gas. It alfo appears, that the firft ftage of vegetation is analogous to combuftion and refpiration, all the three proceffes depending on oxydation by the atmofphere. I fhall clofe this fubject with the following remarks:

I. The only inference in this paper which feems to me doubtful, is, that feeds impregnated with water retain a part of the oxygene they abforb. To determine the matter with more certainty than I have done, the fixth experiment fhould be repeated over mercury.

II. It is probable, that fome Hydrogene efcapes from vegetating feeds, combined with Carbone; becaufe the veffels ufed in the foregoing experiments retained a peculiar fmell, even after being wafhed in clean water, but the action of the air deftroyed it in a few hours.

III. I have found, that fteeped grain confined, for four or five days, in fmall quantities of common air, will fometimes vegetate, and not in other cafes. This, perhaps, is owing to variations in the general temperature; for when the Thermometer ftands higher than 56°, it is probable, that the putrefactive fermentation commences fooner than when it is below that point. Laftly, the ufe, and even the neceffity of having the foil very well

pulverized, for the reception of a crop of grain or pulse, is explained by the preceding facts and observations: For when the turf of a field is reduced to a fine powder, the air finds free access to every part of it; and the seeds it contains, being placed in a temperature that is nearly uniform, and supplied with a necessary portion of humidity from the moist ground, are exposed in the most favourable manner, to the united effects of those causes, which are intended by nature to promote the growth and prosperity of the infant plant.

On Plica Polonica. *By* Mr. Frederic Hoffman, *Surgeon to the Prussian Army.—Communicated by* Dr. Ferriar.

READ, MARCH 22, 1793.

Synonyms. *Lues Pocusiensis:* Tricæ: Trichoma.* Pol. *Koldun or Gozdz.* German. *Juden-zopff: wichtel-zopff: wixel-zorff: weichel-zorff.*

DISEASES, the tendency of which is fatal, and the occurrence frequent, peculiarly claim the attention of the practical physician; while morbid affections which appear more rarely, and present unusual phænomena, more especially attract the enquiries of those

* *Pokusia* is a territory of Poland.

thofe whofe object is the extenfion of general fcience. The difeafe termed Plica Polonica is of the latter clafs. It is endemic in Poland; and feldom, if ever, obferved in any other part of Europe. During a long ftay at Breflau in Silefia, I had frequent opportunities of obferving this difeafe: and, as it is at prefent little known in Britain, I truft a brief narration of the principal circumftances connected with it will not prove uninterefting.

Both fexes are equally liable to the attacks of Plica. It ufually appears during infancy; and but feldom after the age of twenty. When once produced, it continues during the remainder of life. The acceffion of the complaint is in general preceded by irregular fpafmodic affections, pains in different parts of the body, a flow fever, and various difeafes of the eyes; all which ceafe immediately on the appearance of the Plica.

The diforder confifts in a præternaturally rapid growth of the hair, with a copious fecretion of a vifcid matter from its bulbs. For the moft part, the hairs of the head are alone affected; and that only in peculiar parts. In thefe, the hairs grow confiderably longer than in the reft; and are knotted and entangled with each other; being alfo covered with the vifcid matter which iffues from their roots, and which affifts in gluing them together.

In proportion as the quantity of this gluten, and the implication of the hair increafes, it is ftill more and more difficult to clean and comb it; hence a degree

a degree of Phthiriafis is produced, and the head contracts an extremely fœtid fmell, to which however the Polifh Peafants are fo much accuftomed that they endure it without complaint, or any manifeft inconvenience.

It is alfo an opinion univerfally prevalent with them, that the difeafe is a falutary effort of nature to expel a morbid matter from the body; and that to interrupt the courfe of it would be productive of imminent danger; hence they make no attempt to cure, or even palliate the complaint. And if we may repofe confidence in Authors of eftablifhed reputation, morbid affections of a fimilar nature to thofe which precede its occurrence, paralyfis, and even death itfelf, have fucceeded imprudent attempts to check the progrefs of the difeafe. In this refpect, Plica bears fome analogy to the *exanthemata*, and various chronic cutaneous eruptions.

I am as yet unable to decide whether this complaint is hereditary or not. From fome obfervations indeed it appears, that a predifpofition to it may be tranfmitted from parents to their offspring; but my information on this head is too limited to afcertain the point. In one cafe which fell under my own obfervation, two brothers had Plica, both on the left fide of the head, and in about one third of their hairs: I learned from them, that their father and grandfather had alfo been affected with the difeafe in a form exactly fimilar.

Befides

Befides the human fpecies, other animals are fubject to this complaint. It appears in fome of the fineft horfes in Poland. In them it is fituated in the mane, and fometimes in the long hairs around the hoof and fetlock joint. It attacks alfo the different fpecies of the canine genus; dogs, wolves, and foxes. Previous to its occurrence in the firft, the fymptoms of *rabies* ufually appear: the tail is dropped between the hind legs, there is a flow of frothy faliva from the mouth, the fight and appetite are impaired, or entirely loft; they are fnappifh, and difpofed to bite, but their bite does not produce hydrophobia. The wolf is affected in the fame manner; he leaves his wonted concealments in the woods, and runs wildly among the flocks, biting, and deftroying them, but without producing hydrophobia.

The impoffibility of afcertaining the true caufes of this fingular difeafe, has given rife to feveral vague conjectures on the fubject; as that of Le Fontaine, who attributes it to a corruption of the fat.

It is fomewhat remarkable, that Plica takes place only among the lower clafs of people; whence fome have conceived, that it is to be confidered merely as a confequence of uncleanlinefs.

But, in objection to this opinion, it may be urged, that it is unknown in the adjoining countries fubject to the Pruffian Government, where the peafants are habituated to the fame cuftoms and mode

mode of life, or nearly the ſame as in Poland—that its appearance affords evident relief to the ſyſtem, and its retroceſſion is productive of dangerous conſequences. The idea that it is a real and idiophatic diſeaſe, is confirmed alſo by its occurrence in a variety of animals, and by the circumſtance of its being confined to particular parts of the head; for which no reaſon can be aſſigned on the former ſuppoſition.

A peculiarity of climate cannot be adduced as a cauſe of this diſeaſe. Poland differs little in this reſpect from the adjoining countries. The ſummer heat is conſiderable, the thermometer riſing frequently to 98°. 100°. 104°. and the cold in winter ſo great, that it falls ſometimes 10, 15 degrees below 0. But though the changes in the atmoſphere are ſo remarkable, at different periods of the year, they take place with the utmoſt regularity, the temperature paſſing, by inſenſible degrees, from one extreme to the other.

The Poles themſelves are a vigorous, hardy race; inured from infancy to labour, and to expoſure to the viciſſitudes of the atmoſphere; almoſt regardleſs of cold, they frequently ſleep in the open air. Their diet conſiſts chiefly of animal food, and they are much addicted to the uſe of ſpirits. They have an equal fondneſs for other ſtrong ſtimulating liquids. I have ſeen them drink, with the greateſt pleaſure, the ſalt brine in which herrings have

have been preferved, and even nitrous acid diluted with water.

Since no other caufe can be affigned for this difeafe, it is probable, that it arifes, according to the general opinion, from contagion; a contagion which, like that of Pfora, can be communicated by contact only: but this I have not been able to afcertain by any obfervations of my own.

It is faid, however, by authors of reputation, that Plica is frequent in Tartary; and that it was brought into Poland in the thirteenth century by the Tartars, who at that period made frequent irruptions into the eaftern parts of Europe.

A perfect confidence in the liberality and candour of a Society, the exertions of which have added confiderably to the treafures of fcience, encourages me to fubmit to it thefe few crude and curfory remarks; trufting that the moft trivial contribution to the general ftock, will not be deemed unworthy its attention. At fome future period I hope to have opportunity and leifure to renew my obfervations upon the fubject; and I fhall endeavour to fupply the deficiences of the prefent Sketch, by tranfmitting to the Society the refult of my future remarks.

On the Combustion *of* Dead Bodies, *as formerly practiſed in Scotland.* *By* Mr. Alexander Copland.

READ, OCTOBER 4TH. 1793.

To Mr. HARVEY,

Secretary to the Mancheſter Literary and Philoſophical Society.

SIR,

BEING informed that ſome Antiquarian Members of your Society were not altogether ſatisfied with the explanation given of the uſe of the Iron Inſtruments, deſcribed in the laſt half-volume of the Memoirs of the Literary and Philoſophical Society of Mancheſter; I have ſtated ſome additional facts, and farther remarks on the ſubject, which I requeſt you will preſent to the Society; and which I hope will be accepted of as a Sequel or Appendix to my former Paper.

I have the honour to be,

Your moſt obedient and obliged ſervant,

ALEX^R. COPLAND.

Dumfries, Sept. 30, 1793.

THE

THE following appear to be the principal arguments advanced in oppofition to my opinions, concerning the ufe of the Inftruments defcribed and delineated in the laft half-volume of the Society's Memoirs.

I. That the fubject was of fo very uncommon a nature, as hitherto to have efcaped notice.

II. That the Inftruments defcribed might have been applied to other purpofes, as hufbandry, punifhment, or torture.

III. That there appeared no neceffity for the ufe of an iron apparatus in the procefs of confuming dead bodies.

IV. That the fufpending of bodies for the purpofe of combuftion was indecent; and likely to caft fome reproach on the memory of thofe, whofe corpfes had been thus treated.

In anfwer to the firft objection I wifh it to be obferved, that although this fubject has been much neglected hitherto by antiquarians,* yet the frequency of the objects in this country, and the

 numerous

* Mr. Pennant, in the firft volume of his Tour through Scotland, is perhaps the firft who defcribes Cairns as Sepulchres, for the Afhes of thofe, whofe corpfes had been confumed by fire.

numerous opportunities that have lately occurred to examine the contents of Cairns and other ancient Cœmeteries, have at last brought it into notice. In a statistical Account of the parishes of Rutherglen and Killbride, recently published at Glasgow, the author, Mr. David Ure, has confirmed every thing I have advanced respecting Cairns being true sepulchres; and added several interesting particulars of a similar nature.

He also (page 223) takes notice of a large Sepulchre, containing a number of urns, and a quantity of fragments of bones, situated in a place bearing a similar name to that where the instruments were found; and which appears to agree, in several respects, with the inclosure first described by me. It is called Strath-Blane: Strath means a portion of low and level ground, generally divided by a river;* and Blane seems to be the appellative or distinguishing name of this, from other Straths, being in all probability a Saxon word, (as none of the Highlanders I have spoken to seem to know its meaning) importing a place of sepulture. The farm at Caerlaverock, in which the cœmetery is situated, is called Kell-blane: Kell (i. e. Cell)

* Thus, in Scotland, we have Strath-More, Strath-Spey, Strath-Erne, Strath-Avon, &c. being long and level vales, with rivers of the names of More, Spey, Erne, &c. running through the midst of them.

Cell) intimating ſome place reſpected from pious or ſuperſtitious motives; or, as it may with ſeeming propriety be tranſlated, the holy burying place, or *Cæmetery*: For, in this country, the reſidences of holy perſons or ſaints were called Kells or Cells, upon moſt of which churches are now built, and they are therefore at preſent generally called Kirks; and hence ſome proper names, which in former times began with Kell, are now changed to Kirk.* In conſequence of the appellative Blane being joined in both inſtances to two ſubſtantives, that are generally conjoined with ſuch diſtinguiſhing marks; and as there are Cœmeteries in both places, we are led to conclude, that the name in both has originated from this ſole ſource.

Mr. Ure farther narrates, that a ſpade, reſembling thoſe found with the iron apparatus, was diſcovered lying with fragments of bones and urns under another Cairn.

We may certainly, therefore, be allowed to conclude from this ſimilarity of names, and poſition of inſtruments,

* Thus we have in this country Kirkcudbright, *olim* Kell-Cuthbert, Kirkmichael, *olim* Kell-Michael, &c. with at leaſt four pariſh churches of the name of Kirkpatrick, which were the cells or places where St. Patrick reſided whilſt on his Miſſion of Converſion, before he went to Ireland; and alſo the name of a family, now called Kirkpatrick, but which, in all old authors, is ſpelled Kell-patrick.

inſtruments, that they were uſed for the expreſs purpoſe I have ſtated, and appertained to repoſitories of the dead. But what ſeems to confirm this poſition almoſt beyond a doubt, is the particular ſituation in which the iron inſtruments at Kell-Blane were diſcovered, being all included in one oblong niche, covered with common mould or earth. They conſiſted of a number of very ſtrong and moſt curious chains; a pillared ſupporter; rings and blunt hooks highly ornamented; hoops of a different conſtruction from thoſe now in uſe; a pitchfork having its prongs ſquared, and therefore unfit for being uſed in huſbandry, and alſo too large for culinary purpoſes; and a pair of large tongs.* Theſe inſtruments, all of iron, with two ſpades or ſhovels, were depoſited together in ſuch a manner as plainly ſhewed, that they were intended to be uſed in concert, and only on very particular occaſions. It was evident, that great care had been taken to conceal them, as will more fully appear from the following ſtatement.

I was

* A pair of large tongs were alſo found along with the other inſtruments, but in ſo conſumed a ſtate, that they preſently fell to pieces, and therefore could not be included in the number of thoſe articles put into Mr. Riddel's poſſeſſion. They were of the kind ſtill in uſe amongſt the common people here, having blades or ſides above three feet long. Mr. Wilkins, the farmer of the ground, who was preſent when they were diſcovered, informed A. C. of this circumſtance, ſoon after he had tranſmitted his paper, on this ancient Mode of Sepulture, to Dr. Percival.

I was lately informed by the farmer of Kell-Blane, or Kirkblane as it is more commonly though improperly called, that he had made some farther discoveries at the place where the articles of iron had been found, in consequence of my request, that he would be particularly attentive when cultivating that spot.

I went with him, accompanied by two of his servants, to a spot elevated about four feet above the ground around it, which, except in this part, slopes gradually to Locker Moss; and at the summit of this rising ground, I found a hearth, upon which wood had been burned at a distant period, there being a quantity of it charred lying on the surface of the till and stone pavement;* the grain of the wood was perfectly distinct, but the ashes, if such they could be called, though nearly of the usual colour, were changed to an earthy mould, much mixed with sand; this last was only found in the middle, and mostly in the interstices of the stones, as also below one or two of them.

The hearth appeared, on thorough examination, to be of an elliptical form, like a boat, the mouth of a spoon, or section of an egg-shell: being deepest in the middle, and covered over with good earth about two feet deep; becoming gradually shallower towards the edges, where it was one foot below the surface. Its dimensions were ten feet long by six broad over

* The incorruptibility of charred wood is well known.

over the centre. It was paved with flat ſtones, that bore evident marks of ſcorching from fire, in the midſt, and on the North-Eaſt and broadeſt end, where probably the head of the corpſe had been ſuſpended; but the other end was excavated out of the hard till, with a ſtratum of two or three inches of charcoal ſpread over it. The eminence was ſituated about fifty paces North-Eaſt of the middle of the large cœmetery deſcribed in my paper; and about twenty-five paces South-Eaſt of the hearth was placed the niche, which contained the iron chains, &c. This laſt was cut out of the hard till, on the ſide of the riſing ground, where no water could lie; and was covered with a rich mould. At the diſtance of fifty paces farther, on a low part of the ground, in the ſame direction, a rounded ſtone was obſerved, of a larger ſize than any in the neighbourhood, requiring the exertions of three men to turn it over. It was placed on a pavement of common round ſtones, to prevent its ſinking.

This was evidently a land-mark, by which the niche, containing the iron apparatus, could always be diſcovered; though a circumſtance by no means capable of attracting the notice of any, except thoſe who came with the expreſs purpoſe of finding it.

I would therefore aſk any unprejudiced perſon, how he can poſſibly ſuppoſe, that this land-mark; the niche incloſing the extraordinary aſſem-

blage

blage of Inſtruments; and the elliptical Hearth, bearing evident marks of conſiderable uſage; ſhould be all ſo particularly ſituated in the ſame ſtraight line, in the immediate vicinity of a large cœmetery, and at the diſtance of two hundred and fifty yards only from a large cairn, (out of which the farm houſes upon the ground have been built) except for the expreſs purpoſe I have aſſigned to them, viz. for conſuming the bodies of the dead, with as little expence of fuel as poſſible.

And ſurely nothing could accompliſh this purpoſe ſo effectually as the concave form of the hearth. For this, when the comburator and other apparatus were uſed, by concentrating the heat around the body, would produce a much more complete combuſtion with leſs expence of fuel, than if the hearth had been upon a level.

From the ſituation alſo of this hearth, which is conſiderably under the height of that which appears to have been in the midſt of the cemetery, it could not be ſeen, when uſed, from any part of the ſurrounding country, except from the other ſide of the moſs, which is there three miles broad, and totally impaſſable.

All theſe circumſtances ſeem fully to evince a ſtrong deſire of concealment, both during the ceremony and afterwards, ariſing probably from a favourite practice being partially continued, after it had fallen into general diſuſe; and perhaps after it

had been prohibited by law, and reprobated by the reſt of the country.

II. With regard to the ſecond objection, it is proper to ſtate, that, from the remarkable aptitude which the various articles of the apparatus poſſeſs, for the different parts of the proceſs of combuſtion, we are induced; or, in a manner, conſtrained to draw a ſimilar concluſion. And indeed, on a thorough conſideration, it will appear evident, that the experience of ages muſt have been neceſſary to produce all the different articles of the apparatus, in ſuch perfection, and ſo particularly adapted to ſuſpend every part and fragment of the body, till conſumed, and reduced almoſt entirely to aſhes; for no inſtance can be pointed out as ſuperfluous, except the appearance of ornament on ſeveral of them may be ſo eſteemed. It has been intimated that oſtentation was here needleſs; but ſurely it was not more ſo in thoſe ſuperſtitious times, at this awful and frequent ceremony, than the ſhew generally exhibited in the preſent age upon coffins, at funerals, and on monuments. However excuſable oſtentation may be in ſuch circumſtances, it is ſurely highly improper, as well as unneceſſary, in every article of huſbandry; and if ſuch ſcrolls were to be added to the chains and hooks of carts, ploughs, &c. as were found on thoſe connected with the reſt of the apparatus, they

they would be rendered totally unfit for fuch purpofes.

And, in like manner, the attempt to ornament inftruments of torture or punifhment, would have been equally improper, if not highly ridiculous. The iron hooks, alfo, that in fuch circumcumftances, without doubt, muft have been ftruck into the flefh, for fupporting the miferable victim, (as is ftill done in Ruffia) would have been fharpened; but thefe are broad at the points, and end in large knobs, fo as to fit them only for fupporting and retaining the hoops, &c. over a fire. And the number of hoops, of various fizes, and of fuch particular conftruction, along with the tongs, &c. clearly indicate their being intended for fome procefs, where a heavy body was to be fufpended over a ftrong fire. It may not be improper to remark, that the moft ufeful watch-chain that has been invented, is of the fame conftruction with thofe of the comburator; and I know of no other chain made in that manner.

III. With regard to the propriety and neceffity of ufing an iron apparatus, permit me to obferve, that notwithftanding all the accounts tranfmitted to us by the ancients, of confuming the dead by fire, defcribe the corpfe as being laid on a high and extenfive rogus, or pile; yet all thefe were honours paid to great men, for whom perhaps a whole country might be ftripped of its wood,

But, with reſpect to the lower claſs in a populous nation, ſuch a procedure would appear to be at leaſt impracticable; and at this period, it is evident, that there is not ſo much wood growing, excluſive of gentlemen's plantations, as would conſtruct rogi for the inhabitants who at preſent live in the country; ſo that there would be no wood left for huſbandry, houſe-building, manufactures, &c. That this country was then very populous, and perhaps more ſo than at preſent, appears from the great number of theſe cairns in every part of it; ſeveral of which ſeem to have anſwered the purpoſe of large burying grounds, particularly one I ſaw, whilſt diſmantling, in which fragments of bones were equally diſperſed through every different part — It was at leaſt ſixty feet in diameter, and the putrefaction was ſtill going on ſo freely in it, in conſequence of the internal parts being expoſed to the air, that the workmen who came to it on a foggy morning, were ſo powerfully affected by the ſmell, as to become ſick at ſtomach: it is ſituated within three hundred yards of the cœmetery in which the iron triangle was found.

But farther, if ever wood became ſcarce, in a country where combuſtion of the dead was conſtantly practiſed, from being deſtroyed by war, accident, &c. the dead bodies muſt of neceſſity be conſumed with coppice wood, ſmall branches

branches of trees, or shrubs of various kinds; the trunks of trees, if any existed, being retained for more urgent occasions. The body must have been laid on a pile of brush-wood; and, whenever the fire began to consume, it would, from the weight and moisture it contained, and for want of support for a sufficient length of time, fall to the bottom; and notwithstanding all the small wood that could be heaped on above it, would by no means be properly consumed, but only broiled. They must then have found the necessity of giving the body such support as was sufficient to keep it for a considerable length of time in the focus, or point of strongest action of the fire and flame. When they endeavoured to effect this by means of beams of wood, placed horizontally or perpendicularly, these would be speedily so far consumed as to permit the body in like manner to fall down, and be too low for the complete action of the fire; they must, therefore, at length have been reduced to the absolute necessity of having recourse to instruments of iron, or some other metal.

And, with respect to the opinion, that either peats, turf, or pit-coal, were ever used in this ceremony, I think we have sufficient reason to reject it; for all accounts of burning the dead, that are transmitted to us, agree in this, that nothing but wood was used on the occasion; and being at first solely appropriated to that purpose, no

no other fuel would probably be ever thought of. But at any rate it may be conjectured, that they would never use, for that purpose, fuel situated below the general level of the ground, whilst another could be procured, which, in its natural state, was considerably above its surface, and always endeavouring to ascend and approach nearer to the superior or heavenly regions; being in that respect typical of the expected ascent of the deceased, as a reward for his trials and sufferings in this life; whereas the use of the former would appear, to a superstitious people, ominous and adverse to the fond expectations of his friends. Besides, I believe there are no records of either peats or turf having been much, if at all, used by the Romans; and we are certain, that pit-coal did not come into use as fuel, till long after the period now treated of.

Thus after a full investigation of the subject, I think there is reason to be decidedly of opinion, that the ancients must generally (i. e. in cases of Plebeians) have had recourse to some such apparatus as is here alluded to, of iron, or other metal, for consuming the dead, notwithstanding all remembrance of it may have been lost, as well as of other matters of infinitely more importance to mankind.

Lastly: When we consider, that a number of brass and silver rings, and brass points of arrows and spears, evidently made by, or copied from the Romans,

Romans; and that ſome Saxon coins have been alſo found in many of theſe Cairns;* and likewiſe, that the inſtruments of iron were in a ſtate of high preſervation, it would appear very improbable they could have been uſed above eight or nine hundred years ago; a period at which the Saxons governed in this country, who might have borrowed the cuſtom of burning the dead from the Romans.† If theſe had been inſtruments of torture

* Several of theſe different articles were found in Cairns, in the pariſh of Croſſmichael, and a ſpecimen of each were preſented ſome years ago, by William Copland, Eſq. of Collieſtone, my brother, to the Antiquarian Society of Edinburgh, with a view to their preſervation. Repeated inſtances occur in Sir John Sinclair's Statiſtical Account, under the head of Antiquities, of circumſtances corroborative of my opinions, particularly in the account of the pariſh of Leſlie, volume VI. page 52. A Hearth, exactly ſuch as that firſt deſcribed by me, was diſcovered in the the bottom of a Cairn, with a quantity of burnt bones, rings, and points of ſpears lying upon it.

† This agrees entirely with what we find in the Poems of Oſſian. The graves of his heroes were known by a few large ſtones ſet upright, and no notice is taken of the Funeral Pile, or of the Tumulus or Cairn, which muſt have been introduced poſterior to the period in which theſe Poems were compoſed. Some ſuch ſtones are ſtill known to remain. A deſcription of the Sepulchre of King Galdus, or Galgacus, was ſent by Robert Riddel, Eſq. of Glenriddel, to the Antiquarian Society of London, and will probably ſoon be publiſhed. It is entirely of this kind; for he lived at the commencement of this period.

torture, the punishments must have been very cruel in those days; but we have always understood that our anceftors, the Saxons, were very lenient in their punishment of criminals; death seldom being awarded, and indeed most criminals getting off with fines of greater or less extent. Moreover, from these instruments being found in two parts of this country, at only fourteen miles distance, it would indicate, that enormous crimes, and their equally dreadful punishments, had been infinitely more frequent than at present, or than ever was heard of in any other country.

And also from spades having been found along with the iron apparatus, it is clearly indicated, that whatever had been subjected to the use of these instruments was intended to be inhumed; which certainly would never have been practised with criminals, or prisoners of war, whose corpses were generally left to glut the fowls of heaven, and beasts of prey.

I think at any rate it will be granted, that in consequence of the scarcity of wood, as already explained, numbers of the common people must of necessity have been exposed on such small and low Rogi, as would place the corpses opposite to, or under the eye of the attendants; and consequently in a more *indecent* posture, than when suspended in an iron triangle with the brush-wood placed under, over, and every way around them; and it may be

be proper to remark, that in this manner and pofition *alone* could the corpfe be conveniently and completely confumed.

The cuftom of hanging criminals in chains *in Terrorem*, is, I believe, a modern invention; and, therefore, the idea of the ufe of thefe inftruments being connected with difgrace and punifhment could, at fo remote a period, have no place.

OBSERVATIONS *on the* ADVANTAGES *of* PLANTING WASTE LANDS. *By* THOMAS RICHARDSON, *Efq.*

READ, FEB. 7TH. 1794.

IT has frequently been matter of concern to me, in travelling through different parts of the kingdom, to obferve the decreafe of Timber Trees in almoft every county, whilft many large tracts of land, very fuitable to the growth of wood, remain in a wild uncultivated ftate, of no ufe to their owners, and indeed unfit for any other purpofe than that of planting. Of this kind may be fairly eftimated one eighth part of the kingdom. Why thefe lands fhould remain in

T t this

this unprofitable, comfortlefs, and difgraceful ftate to the owners, when they might be fo eafily converted into fcenes of picturefque beauty, and yield fo much benefit to the proprietors, is a circumftance I have frequently been at a lofs to account for. To the enquiries I have made on this fubject, the moft general anfwer has been, "that wood would not grow on fuch land." But, I am led to conjecture the true caufe to be, that the expence is *immediate*, and the profit at a *diftance*. This doubtlefs has appeared, at the firft view, to many a fufficient bar to improvements of this kind, yet I truft a fair and candid enquiry into facts, with the obfervations I fhall adduce, on different plantations within my own knowledge, will fufficiently demonftrate, that a man may, within the compafs of his own life, (if he begin to plant early) reap the reward of his labour, and alfo enjoy the pleafing reflection of the advantages he is preparing for his children by this rational and amufing employment, as well as the benefit and agreeable fcenery the country will receive from fo laudable an undertaking.

There are three kinds of land generally deemed unfavorable for the purpofes of cultivation; and experience has proved, in moft inftances, that although more pains, labour, and expence have been beftowed in endeavouring to cultivate and

improve

improve fuch lands, than they could poffibly have repaid if the attempt had been fuccefs-ful, the attempt was fruitlefs, and the money thrown away; whilft, with a fourth part of the expence in planting, the advantages would have been certain, and the profits have taken place at an earlier period, and in a much greater degree than could have been hoped for by any method of cultivation.

Thefe three kinds of land are included under the following heads:

I. Boggy Wet Lands, which, from their fituation and nature, cannot be drained without an expence far beyond any probable advantages to be derived from their cultivation.

II. Sterile Hungry Lands.

III. Barren Rocky Hills.

Any perfon who has attentively viewed this country muft have perceived, that lands of this defcription form fully as great a portion of the whole land of the kingdom as I have eftimated. To this may be added, that there are few eftates where there are not feveral parts, either from fituation or afpect, of fmall value for grazing, or the plough; which, by planting, might be turned to much advantage by affording warmth and fhelter to the cattle; keeping the bleak winds from the land; and fupplying the farms with ftore of wood for fuel, fencing, and all the

 various

various ufes for which it is perpetually demanded: And the eventual profit would be certain, from the growth of excellent timber trees, felected from the choiceft and moft valuable part of the plantation.

I fhall confine myfelf, in the obfervations I have to offer, to the three kinds of land fpecified, which, being generally deemed barren, are not of the annual value of fixpence an acre to the owners; and endeavour to prove the utility of applying fuch lands to the purpofes I fhall afterwards mention.

And, firft, of the Wet Lands, and the trees beft adapted for fuch places.

I fhall begin with the Alder, which thrives wonderfully in fwampy ground; and there are few trees of greater general utility: But it is more particularly valuable in this neighbourhood (Manchefter) where its ufes are fo various as to adapt it to an almoft endlefs variety of purpofes. The *wood* of this tree is in great efteem and demand for machinery; the cogs for mill wheels formed of it being proved, by experience, to be fuperior to any other. It is commonly ufed for bobbins; and the country people wear fhoes, or, as they are ufually termed, clogs made of it. Its excellent quality of refifting injury from water is univerfally acknowledged; hence its great value for pump trees, pipes,

pipes, drains, conduits to reſervoirs, piles under water, and all kinds of wood-work which is kept conſtantly wet. The pipes which are laid under the ſtreets of moſt large towns, to convey the water, are generally of Alder; and indeed in all works of the ſame nature, where it can be procured in ſufficient quantity, it is preferred to every other wood. But it is much to be lamented, that the valuable properties of its *bark* ſhould be ſo little known, that in moſt inſtances it is buried with the tree. The black dyers of cotton ſtuffs know its value, and make much uſe of it; they purchaſe it at the rate of ſeven to eight-pence the ſtone, laid down at their dye-houſes. It is not chopped, but ſold as it is ſtripped from the tree, after it has become moderately dry; ſo that there is no expence in chopping and cleaning it, as is the caſe with oak bark. It might be uſed to great advantage as an excellent ſubſtitute for many woods uſed in dying, which we have from abroad, and on which we expend conſiderable ſums.*

A friend

* "The *Koreki*, a ſavage nation inhabiting the borders "of Ruſſia, uſe deer-ſkins and dog-ſkins for their cloath-"ing, which they dye with alder bark reduced to a fine "powder. But their ſeal-ſkins, on which they ſet a "higher value, they dye in a nicer manner.

"They firſt clean off the hair, which they do very

"dextrouſly

A friend of mine had a ſmall piece of marſhy ground, the produce of which never made him a ſhilling for many years. He had ſome thoughts of draining, and endeavouring to improve it for meadow land (the ſituation being favorable); but on my recommendation he planted it with Alders. The extent of it was ſomething leſs than an acre, and the whole expence of planting coſt him no more than twenty ſhillings. The plants did not coſt any thing. He had ſome land over-run with young ſeedlings; two men were employed, who drew them and planted the whole in one week. In five years he cut them over, taking down every third or fourth plant, and thinning them judiciouſly, to afford room for the moſt thriving trees to expand in. Theſe poles produced

" dextrouſly by means of ſharp ſtones. They then ſew up " the ſkin into the form of a bag, turning the hairy ſide " outward; in this bag they pour a ſtrong decoction of " alder-bark, leaving it in this ſituation for ſome days, after " which they hang it upon a tree, and beat it with ſticks, " until the colour has penetrated quite through the ſkin, " ſo as to tinge it equally throughout. They then rip open " the bag; and, ſtretching out the ſkin, leave it in the air " until it is quite dry, after which they rub it with their " hands till it becomes ſoft, and fit for uſe. They alſo dye " the hair of their ſeal-ſkins a fine bright red colour, with " a decoction of red wortle berries, alder-bark, alum, and " *lac lunæ*."

Museum Ruſticum.

duced him fifty ſhillings, and the loppings for fuel more than repaid the expence of cutting down. In ſix years more, they were grown ſo ſtrong and large, that he was under the neceſſity of taking down half of the remainder: Theſe were of courſe the weakeſt trees: They produced in bark and wood, 8l. 14s. The cord-wood became now ſo conſiderable as to be worth infinitely more than the expence of falling and peeling, as many of the branches were fit for ſtakes for fencing, and other purpoſes. It is three years ſince the laſt falling; and the reſt on a moderate calculation, lately made, have been eſtimated at 13l. excluſive of the young poles or ſhoots. Thus, in fourteen years from the planting a piece of ſwamp, rather leſs than an acre, which had never before been productive to the owner, there have been already received eleven pounds four ſhillings; and timber is now ſtanding to the eſtimate of thirteen pounds more: in all 24l. 4s. or 1l. 14s. 7d. yearly. But theſe are not all the advantages reſulting from this plantation; for the leaves fall in ſuch abundance each year, that they have added a tolerable ſoil productive of a coarſe graſs; which, being cut with the ſickle in ſummer, is uſed as fodder for the young cattle within the houſe, during the heat of the day. I ought to obſerve, that, in this eſtimate, no account is taken of the expence

of

of that very neceſſary article to all plantations, Fencing, the ground having been already encloſed. But, on the other hand, it muſt be remarked, that I have ſtated the profits of the plantation to its extent of fourteen years only; that, from the progreſſive ſtate of its improvement, and the increaſed value which growing wood annually acquires after a certain age, it cannot be doubted but, in the next ſeven years, it will equal at leaſt the value of the preceding fourteen years; particularly when it is conſidered, that the ſhoots, from the former cuttings nine years ago, are now ſprung up into poles which are very numerous, and much larger than the parent plants were when cut down: the ſecond cuttings are alſo in a proportionate ſtate of increaſe.

The WILLOW will alſo grow luxuriantly in marſhy ground; and produce great and laſting profit.

There are many ſpecies of this genus, all admirably adapted to various purpoſes; but, on the whole, I would recommend to the planter the three following as entitled to a preference.

The WHITE WILLOW *(Salix alba)*
The SALLOW *(Salix caprea)*
And the OZIER *(Salix viminalis)*.

Theſe three are in the greateſt eſteem; and applicable to every uſe for which trees of this genus are commonly employed.

Of

Of the White Willow I recollect a ſmall plantation being made on a ſwampy piece of ground, in the year 1761, which grew ſo admirably, that the faireſt and beſt trees were cut down in 1786. One of theſe which I meaſured was, at five feet from the ground, ſix feet five inches; and, at the length of thirty-two feet, four feet ſeven inches in circumference. There remained ſtanding about ninety of the ſmalleſt trees, which were then thought unfit for cutting, having been robbed of their growth by the ſhade of the others: I meaſured the beſt of theſe trees at the time the others were cut down, viz. in 1786; it was only three feet ten inches in circumference, at ſix feet from the ground. I again meaſured this tree in 1793, at the ſame height; and it was no more than four feet four inches.

I mention this circumſtance, to ſhew the ſlow progreſs made by this tree in the laſt ſeven years, compared with its growth in the former twenty-five years, under the diſadvantage of being choaked and crouded by its more luxuriant and lofty neighbours: a fact affording full proof of the quick attainment of theſe trees to perfection.

The wood, from its peculiar whiteneſs, is in high eſtimation; and bears a good price for butter-firkins, milk-pails, caſks for liquors, boards for flooring, cheſts, boxes, and various kinds of huſbandry.—It is alſo excel-

lent for the tilts and fides of waggons, being very light, and yet exceedingly tough and pliable.

The Sallow is a very quick growing wood; and extremely ufeful where new inclofures are to be made, either for the improvement of land or raifing plantations, as it makes good ftakes for hurdles.

I cut down one of thefe trees * in the winter, five years ago, from the ftool of which, in the following autumn, a numerous offspring had arifen, fome of which had fhot out to the amazing height of ten feet. In the fpring of the prefent year, (1793) having occafion for fome hurdles to protect a young hedge of hawthorn juft planted, I cut down thefe fhoots for ftakes. They were fomething too flender, but anfwered the purpofe tolerably well. No wood burns clearer, with a brighter flame, or for a greater

* From the bark of this plant in its green ftate, in the year 1788, were made, at Mill-Bank, near Warrington, fifteen reams of ftrong paper. It appears from the teftimony of Mr. Greaves, the maker, that the paper made from ropes is fold at eight fhillings and fixpence the ream; but that paper made from the bark of the *Withen* may be fold, with equal profit, at five fhillings and eightpence the ream: And that pafteboard for book-backs, made from ropes, is fold at twenty-five pounds per ton, long weight of one hundred and twenty pounds to the hundred; but pafteboard of the fame thicknefs, made from withen-bark, may be fold at feventeen pounds per ton.

a greater length of time, than the Sallow. It is even preferable, in this reſpect to the Beech. It emits little ſmoke, and is extremely ſweet and wholeſome.

It is almoſt unneceſſary to ſpeak of the value of the Ozier; for whoever contemplates the conſumption of this eſtimable twig, in the immenſity of wicker and baſket-work which is uſed, muſt be convinced of the importance of its cultivation. The ingenious Dr. Hunter ſays, that a plantation of Oziers will produce from five to ſix pounds the acre annually, provided ſuch plantations be in the neighbourhood of the baſket-maker, or by the ſide of ſome river, which may enable him to ſend his wares by water, at ſmall expence, to a proper market. Yet ſurely, at theſe prices, there are not many places in the kingdom ſuch as have been deſcribed, which may not be ſucceſsfully cultivated, and yield a very handſome profit, excluſive of the expence of carriage, eſpecially ſince the great extenſion of our canal navigation.

The Poplar, being termed by many writers an aquatic, has been frequently planted in an improper ſituation. In lands conſtantly wet, it may live for a few years, but it never arrives to any perfection in them; for where its roots are perpetually wet and cold, early ſymptoms of decay ſoon appear. With the exception

of thoſe now mentioned, this tree adapts itſelf to moſt ſituations. It will thrive moſt luxuriantly on boggy moor-land, after it has been drained, of which I have a ſtriking proof—I had ſome land of this deſcription, ſo wet, as to be totally impaſſable by man or beaſt—After it had been well drained in the winter of 1790, it was planted in the enſuing ſpring with poplars of the following kinds:

The White Poplar *(Populus alba)*—The Black Poplar *(Populus nigra)*—And the Aſpen *(Populus tremula)* and a few of the Carolina or Balſam Poplar.—Theſe trees, when planted, were generally from two feet to two feet three inches in height; and an inch and a half in circumference at the thickeſt part. I meaſured ſeveral of them in July, 1793, and they were, on the average, ſeventeen feet and a half in height; in girth, at the ground, twelve inches and one-third; and at a foot from the ground, ten inches and one-fourth. I have heard of more extraordinary ſhoots in trees of the ſame kind; but I never ſaw any the growth of which on the whole equalled theſe. I planted ſeveral thouſands of them in different ſoils, aſpects, and ſituations, but none have yet come near to thoſe planted in this drained moraſs.—Thoſe on the edges of the brooks, in good ſoil, have ſucceeded next to theſe; then thoſe on ſandy ſoil, and dry heath

lands;

lands; and laſtly, thoſe on the ſtiff clay lands, which, although they have made pretty good progreſs, are yet the worſt of all. Having a few plants left after the drained part was planted, and having heard it frequently aſſerted, as well as ſeen it ſupported by many authors, that they would ſucceed in the wetteſt places, I put them into the adjacent ground, which had not been drained, for the purpoſe of experiment—They ſeemed to ſtrike tolerably well in the firſt year; but in the ſummer of the next, they grew ſickly and turned yellow—I ordered a drain to be cut around them in the winter of that year—This had the deſired effect, for the following ſpring they regained their former healthy hue, but the leaves were conſiderably ſmaller than in the others, and the plants much leſs, both in height and thickneſs; a ſure proof that they will not thrive, or indeed live long, where the ſituation is too wet. Of the kinds thus planted, in the ſame ſituations, the white and black poplar grew the beſt; and on every account I prefer them, particularly the former.—It is ſcarcely poſſible to enumerate the many excellencies of this tree. To its valuable quality of adapting itſelf to ſo many different ſoils and ſituations, may be added the eaſe with which it is propagated. If the ſide-ſhoots be taken from the parent tree, planted in the ground, and defended from the bite of

cattle,

cattle, they will need no farther attention. I put a number of cuttings, about a foot in length, into some ground well trenched, in the spring; and, in the autumn of the same year, they were grown to the height of upwards of four feet, were well rooted, and remarkably fine plants. They are of such rapid growth, that I saw a fall of this timber, which grew in a hedge-row, and had been planted twenty-five years, sell, on an average, at twenty-one shillings each tree; and I was afterwards informed that this price was much beneath their real value. I planted some Poplars (what we term Lombardy Poplars), about twelve years ago, which are now three feet two inches in circumference at the thickest part, and upwards of forty feet high. This is a pleasant looking tree, and does well enough in an ornamental plantation; but the wood is of little or no value. Another considerable advantage in the white or black Poplar, is that a greater number of them will grow on the same space of land, than of any other tree: For it is requisite, that all the side branches be dressed off, every two or three years, nearly to the top of the tree. This gives so much freedom to the circulation of the air, and admits the sun so freely among them, that, on the same space of land, may be brought to perfection, a number double to that of any other tree—For this reason we see them

so

ſo frequently planted in hedge-rows, by the ſides of meadows and corn fields, in Lancaſhire and Cheſhire, the farmers holding an opinion, that from the loftineſs of the trees, and from their being kept lopped as I have deſcribed, they do no damage by their ſhade to the herbage or grain beneath them. It muſt be admitted, that they will do leſs injury than trees whoſe numerous branches and thick foliage are impervious to the ſun and air; but I cannot agree that they do none at all: And, notwithſtanding the beautiful appearance which trees planted in this manner give to the face of a country, I muſt condemn the meaſure of planting timber trees of any kind in hedge-rows, as being highly injurious to the fences beneath their branches, and the lands within their ſhade.

The wood of this tree is applied to many purpoſes: It makes excellent boxes and packing-cheſts, in which the manufactures of this town are conveyed abroad. Indeed there are few uſes to which it is not applicable. With many people it is in high repute for flooring-boards, on account of its quality of reſiſting fire; for it burns with difficulty, and ſeldom burſts into a flame: on this account it is certainly very valuable in buildings. I am of opinion that no wood can be better adapted for falſe keels, or planking the inſide of ſhips than this:

this; and, in the ſcarcity of oak timber, every thing which can be found as a ſubſtitute, or may tend to leſſen its conſumption, muſt be conſidered of importance to the country.

The loppings and underwood afford excellent poſts, rails, hurdles, and fencing.

Young cattle delight to feed on the leaves and freſh ſhoots of this tree more than any other; and where there are large plantations of it, in dry ſcorching ſummers, when the paſtures afford little graſs, the leaves will be found an excellent relief to farmers who have large ſtock of young beaſts. If gathered in ſummer and cured like hay, they ſupply a valuable ſubſtitute for that article in ſeaſons of ſeverity.

The leaves fall in autumn in great abundance, and when left on the ground, improve it ſo much, as to render barren moor land fertile in a few years; and to thoſe who live at a diſtance from great towns, and find a difficulty in procuring manure, I know few things of equal value in the improvement of all ſoils, but eſpecially the light, thin, poor ones—Mixed with earth, they form a uſeful compoſt, and with the addition of a little kelp and lime, a cheap and excellent manure, as I can aſſert with confidence derived from experience.

The Birch is alſo a tree which will grow well in the ſituation I have been deſcribing; but, as

as this tree alſo delights in a light ſandy ſoil, and as we need not its additional evidence to prove the advantages of planting barren waſte lands, while we have many ſuperior to it in value and in beauty, I ſhall paſs over it, and proceed to land of an oppoſite deſcription to what has been now conſidered.

II. Several parts of this kingdom abound in dry burning ſands, in barren heaths, and moors unfavourable to every purpoſe of cultivation. The advantages which may reſult from planting ſuch lands, may, in ſome degree, be appretiated by the recital of a few circumſtances which have fallen within my knowledge:

I ſhall begin with a ſmall plantation of Scotch Firs (*Pinus ſylveſtris*), growing on a moor in the North Riding of Yorkſhire. This plantation is on a high mound of grey ſand, in extent not more than three-fourths of a ſtatute acre, which was laid down for this purpoſe thirty years ago. Its utmoſt value could not be eſtimated at two ſhillings and ſixpence an acre annually. But that the ſubject I treat of, and its advantages may not be over-rated; and that no one may be led into error, I will allow at the rate of five ſhillings an acre, and calculate the benefits ariſing from it; ſtating the expences of planting and fencing agreeably to what I have paid myſelf for the ſame kind of labour; and eſtimating the timber, according to the valuation of an experienced perſon,

 who

who examined it carefully, and offered the prices he ſtated, for the trees as they ſtood.

The whole fence was thirty-four rods in extent, of ſeven yards to the rod.

		s.	d.		£.	s.	d.
Caſting the bank per rod	-	1	0				
Quicks coſt	-	0	3				
Poſts and rails	-	1	3				
34 rods, at	-	2	6	is	4	5	0
Planting 1200 Firs { coſt per 100 raiſing 1s. 0 12 0; making holes and planting 1s. 0 12 0 }					1	4	0
Thirty years rent of three-fourths of an acre, at 3s. 9d. per annum					5	12	6
Incidental expences (ſuch as cleaning the plantation the firſt four years; keeping up the fence; and putting in trees where any failed) I eſtimate at					6	0	0
					17	1	6
There were ſtanding 980 large trees, which at a low valuation of 2s. 6d. each, is					122	10	0
Neat profit in thirty years					105	8	6

Therefore, after eſtimating the land much beyond its value, and making a full allowance for the coſt and expences, it appears, this ſmall plot of ground produced 3l. 10s. annually.

Here is another proof then of the great benefit reſulting from planting ſuch grounds: I have taken the eſtimate of the quantity of trees firſt planted at 1200, to allow for ſome failing; but I have made no account whatever of the trees which were taken out as they grew up, to give room for the increaſe of others, which would doubtleſs have more than repaid the labour of weeding and cleanſing the plantation for the firſt four years; and alſo abundantly ſupplied the fences, if any were broken down, before the quicks grew up ſufficiently.

As

As I have ſtated my concern at the general decreaſe of timber trees in the kingdom, and the extent of land ſo admirably adapted for the purpoſes of planting now lying waſte, it is but juſtice to mention, that there are ſpirited individuals, both in England and Scotland, who have raiſed noble plantations of trees, in a ſtate of annual improvement, on land which before produced little or nothing, being of ſo poor a quality that an acre of it would ſcarcely afford maintenance to a ſingle ſheep: on ſuch are now growing thouſands of valuable trees, rapidly advancing to profitable timber.—Among the foremoſt of theſe, may be ranked the plantations of the Earl of Fife, in the counties of Aberdeen, Banff, and Moray in North Britain. This nobleman, in the ſpace of thirty years, has planted ſeven thouſand acres of bleak inhoſpitable moors, and covered with beautiful foreſts a large extent of country on which a ſingle tree never grew before; and where it was a general opinion, that trees could not thrive from the poorneſs of the land, and its vicinity to the ſea coaſt. Another ſpirited undertaking of the ſame kind in the North of England, at Butsfield on Lancheſter Moor, in the county of Durham, has been executed by Mr. White of Retford, in Nottinghamſhire.—Accounts of both theſe plantations, and their increaſe, are detailed in a letter from the owners, addreſſed

addreffed to the Society in London, for the encouragement of Arts, Manufactures and Commerce, and inferted in Vols. V. and VI. of that Society's Tranfactions.

An acquaintance of mine who formerly refided near Butsfield, before Mr. White began his plantation, told me, that no land ever exhibited a more forbidding appearance, and that it was a prevailing notion in the country that the fum expended for its improvement would be thrown away: an opinion, to which, at the time, he was much inclined to accede. On his return, however, after an abfence of a few years, with equal pleafure and furprize, he beheld the fpot which he had left a barren wafte, covered with goodly trees, at once an honour and benefit to the fpirited undertaker, and an ornament to the country.

Thofe who forbear to plant their heath or moor-lands, from a fuppofition that they are incapable of rearing trees, may take an example of the fallacy of that idea, from the thriving ftate of the plantation which the Duke of Bedford has raifed on Woburn fands.—A few years ago, the ground was a barren wafte of hungry, fterile, devouring fand, which fcarcely yielded fuftenance to a blade of grafs—the laft time I paffed the place it was changed into a wood of healthy thriving firs. I mention this young and fmall plantation, becaufe

becauſe every one who has paſſed that road muſt be convinced, that no land could have a more unpromiſing appearance for the growth of wood than this had.

I truſt it has been proved by the foregoing facts, that two of the moſt unpromiſing kinds of land, in which this kingdom abounds, and which have hitherto been deemed barren, may, by attention, be brought to be equally, if not more profitable, than lands of the beſt quality in the uſual courſe of huſbandry.

Among the obſervations made, I have only pointed out ſuch trees as ſeem beſt adapted to each ſituation; but I wiſh it not to be inferred from this, that others of our beſt and moſt valuable timbers will not alſo grow on the ſame ſituations—The contrary is the fact. And it is neceſſary that a judicious mixture of oak, aſh, elm, and many other woods ſhould be made in forming a plantation. The kinds I have deſcribed as moſt deſiring theſe ſituations, and being of quick growth, will become excellent nurſes to others; and, as they attain maturity, or grow too thick, may be removed to make room for the reſt, and thus furniſh a conſtant ſucceſſion of profits from the firſt planting. I cannot here refrain from ſpeaking greatly in favour of the Larch Fir, *(Pinus Larix)* both as a tree of great beauty, which will make prodigious advances in ſuch land as I have laſt deſcribed,

deſcribed, and alſo as a wood of great value, and an excellent defence for other trees, forming in a ſhort time a comfortable ſcreen around thoſe that are leſs hardy. I have planted large numbers of them round ſome plantations I have made; and nothing can exceed the beautiful appearance theſe lively ſkirts of green exhibit early in the ſpring.

III. The laſt kind of land I ſhall notice in theſe obſervations, are thoſe mountainous tracts of barren rocky hills, which are met with in many parts of the country; and which at preſent are nearly uſeleſs. It is unneceſſary to enlarge much upon this ſubject, where the facts lie ſo much within the range of common obſervation. View the large chain of hills, or rather rocks, which ſeparate the vale of Cleveland from the moors in the North Riding of Yorkſhire! Theſe hills are clad with oaks from the foot to the ſummit. Between Thirſk and Stokeſley, woods of this deſcription afford a moſt charming and delightful appearance for miles together: where the land in general, a flinty rock ſloping to the north, is incapable of cultivation, having little or no ſoil, except the ſcanty portion which the rains have waſhed into fiſſures and crevices. In theſe oaks have fixed their roots, and made ſuch growth, that, on one of the hills, a ſurvey of the timber made

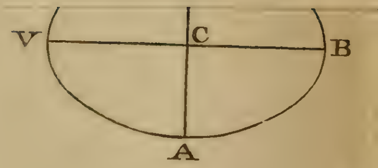
made about two years ago, as I am informed, eſtimated its value at thirty thouſand pounds. What a noble fortune to the younger branches of the family to whom this wood was left!

Evelyn tells us, in his *Sylva*, of an Italian Nobleman, who, after his Lady was brought to bed of a daughter (conſidering that wood and timber were a revenue coming in whilſt the owners were aſleep) ordered his lands to be planted with 100,000 trees, calculating that each tree might be worth twenty-pence by the time his daughter became marriageable, which would amount to near 10,000l. which he intended to be her portion.

This practice I am told is not uncommon in Holland, where they plant the Abele for the purpoſe of portioning out the younger branches of families; and this ſyſtem muſt have our warmeſt approbation, if we conſider the certain advantages reſulting from it, and the benefit derived to a country from keeping up a ſucceſſion of timber. Boucher reports, that he ſold elms, of his own raiſing, at twenty-four years growth, for one guinea each, and theſe not ſelected, but a whole line of them together, conſiſting of above ſixty in number: And he farther informs us, that he planted the eighth part of an acre of ſterile red clay-land with aſh trees, the product of which, in twenty-three years, was after the rate of £115 : 10 : 0. an acre, or

or £5 per acre annually. But to detail proofs of advantages of this kind, eſtabliſhed on unexceptionable authority, would require a volume. One circumſtance, however, I cannot avoid mentioning. It is on the authority of Evelyn. He ſays, "It is ſuppoſed there may "be twenty-ſix millions of ſquare acres in "the kingdom (excluſive of fens, highways, "rivers, &c. &c. not eſtimated). Now, "value but the annual growth of timber at "four-pence each acre; and it will amount to "nearly half a million ſterling, excluſive of "the maſt and loppings." But if I eſtimate right, that, out of theſe twenty-ſix millions of acres, one eighth part is deſtitute of any profits whatever, and yet capable of being improved (as I truſt has been ſhewn): allowing the annual growth of each acre to be no more than ten ſhillings on the average, the benefit to the country is upwards of one million five hundred thouſand pounds each year, excluſive of the timber growing on the remaining twenty-three millions of acres. And, when we conſider the large ſums paid to foreign countries for timber, and its increaſing ſcarcity in this, it will ſurely be worth the conſideration of every true friend to his country, and every benevolent and patriotic mind, to reflect but a moment on the eſtimate thus moderately calculated. Let him then draw

the



B

the concluſion in his own mind, what profits will accrue to every judicious planter of timber, and what advantages our poſterity and our country may reap from ſuch exertions.

The INVERSE METHOD *of* CENTRAL FORCES.

Communicated by EDWARD HOLME, M. D.

THE following Tract being upon a ſubject of conſiderable difficulty, the writer of it (whoſe name we are not permitted to mention) hopes it will be examined with due candour and lenity.

He is aware, that if it contain any thing new, it is in the third propoſition. But, as it could not be eaſily detached from what precedes, this circumſtance will he truſts be an apology for troubling the reader with *the whole* of what he has here done.

If proper *data* could have been procured, an attempt to calculate the motion of the Moon's *apſides* would have been made. But finding that a very ſmall variation in the requiſites already known affects the concluſions conſiderably, it was thought beſt to proceed no farther at preſent in ſo very complicated an enquiry.

THE INVERSE METHOD OF CENTRAL FORCES.

PROPOSITION I.

THE centripetal force being inverſely as the nth. power of the diſtance from the centre, and the direction and velocity of a body at any point v being given; to determine the orbit, &c.—

Fig. I. Let C be the centre of force, V the point from which the body is projected, VnW the trajectory in which it moves, and VZ a circle deſcribed from the centre C at the diſtance CV: to the points V, n, of the orbit draw the tangents VP, np; and from the centre of force C let fall the perpendiculars CP, Cp upon the tangents; join C, n, and produce Cn to Y, and draw CtX indefinitely near to Cny; laſtly, draw tv perpendicular to Cn. Put $CV = r$, $CP =$

$CP = P$, $Cn = y$, $Cp = p$, the velocity at $V = v$, the velocity at $n = \acute{v}$, the velocities being meafured by the fpaces defcribed in the time (1).

If O be the centre of curvature of the trajectory at the point n, then it is well known that $On = \frac{y\dot{y}}{\dot{p}}$. Draw OR perpendicular to Cn; the triangles Cpn, ORn are fimilar, therefore Cn $(y) : Cp\ (p) :: On \left(\frac{y\dot{y}}{\dot{p}}\right) : Rn = \frac{p\dot{y}}{\dot{p}} = \frac{1}{2}$ chord of curvature paffing through the centre of force. But the centripetal force, eftimated by the velocity generated in the time (1), is = the fquare of the velocity divided by $\frac{1}{2}$ the chord of curvature $= \acute{v}^2 \div \frac{p\dot{y}}{\dot{p}} = \frac{\acute{v}^2\dot{p}}{p\dot{y}}$; and $p^2 : P^2 :: v^2 : \acute{v}^2$; therefore the centripetal force $= \frac{P^2 v^2 \dot{p}}{p^3 \dot{y}}$. Let this expreffion be put $= \frac{A^{n+1}}{y^n}$, A being a conftant quantity; wherefore $\frac{P^2 v^2 \dot{p}}{p^3 \dot{y}} = \frac{A^{n+1}}{y^n}$. Multiply both fides of the equation by $\dot{y}$, and take the fluents, then $\frac{P^2 v^2}{2p^2} = \frac{A^{n+1}}{\overline{n-1} \times y^{n-1}}$. But at V this equation becomes $\frac{P^2 v^2}{2P^2} = \frac{A^{n+1}}{\overline{n-1} + r^{n-1}}$, therefore the correct fluent gives

$$\frac{P^2 v^2}{2p^2} - \frac{v^2}{2} = \frac{A^{n+1}}{\overline{n-1} + r^{n-1}} \times \frac{r^{n-1} - y^{n-1}}{y^{n-1}}.$$

If a body descend directly towards the centre by an accelerating force $= \frac{A^{n+1}}{y^n}$, and $u =$ the velocity it has acquired when at the distance y from that centre, then it is well known that $\frac{A^{n+1}}{y^n} \times -\dot{y} = u\dot{u}$. Take the fluents; then $\frac{A^{n+1}}{\overline{n-1} \times y^{n-1}} = \frac{u^2}{2}$, or $\frac{2A^{n+1}}{\overline{n-1} \times y^{n-1}} = u^2$, which requires no correction if the body descend from an infinite height; for in that case both sides of the equation vanish at the same time. At the point V, therefore, or at the distance r from the centre, the square of the velocity acquired by descending from an infinite height $= \frac{2A^{n+1}}{\overline{n-1} \times r^{n-1}}$. Let therefore in general $\frac{2mA^{n+1}}{\overline{n-1} \times r^{n-1}} = v^2$, where m may be either greater, equal to, or less than unity. Hence by substitution and reduction, we have

$$1.\ p = \frac{\sqrt{\frac{m}{m-1}} \times Py^{\frac{n-1}{2}}}{\sqrt{y^{n-1} + \frac{r^{n-1}}{m-1}}}, \qquad m > 1.$$

$$2.\ p = \frac{P}{r^{\frac{n-1}{2}}} \times y^{\frac{n-1}{2}}, \qquad m = 1.$$

$$3.\ p = \frac{\sqrt{\frac{m}{1-m}} \times Py^{\frac{n-1}{2}}}{\sqrt{\frac{r^{n-1}}{1-m} - y^{n-1}}}, \qquad m < 1.$$

There-

Therefore it is evident, that if a body be acted upon by a single force which tends to a fixed point, the law of that force being given, the equation of the curve it describes has been determined: except in that particular case where $n = 1$, or the force is inversely as the distance of the body from the centre; for then the above equations fail.

Take $s : 1 ::$ velocity in the curve at V (v): velocity in a circle at the same distance $= \frac{v}{s}$, then $\frac{v^2}{s^2} \div r = \frac{v^2}{s^2 r} =$ force at $V = \frac{A^{n+1}}{r^n}$; whence $v^2 = \frac{s^2 A^{n+1}}{r^{n-1}} = \frac{2m \times A^{n+1}}{\overline{n-1} \times r^{n-1}}$, therefore $s^2 = \frac{2m}{n-1}$, and $m = s^2 \times \frac{n-1}{2}$; which value of m may be substituted for it in any of the three equations found above.

When $n=1$, we have $\frac{P^2 v^2 \dot{p}}{p^3} = \frac{A^2 \dot{y}}{y}$; hence, by taking the fluents, $\frac{P^2 v^2}{2p^2} = A^2 \times log. \frac{1}{y}$; but at V, this equation becomes $\frac{P^2 v^2}{2P^2} = \frac{v^2}{2} = A^2 \times log. \frac{1}{r}$; therefore the fluent corrected gives $\frac{P^2 v^2}{2p^2} - \frac{v^2}{2} = A^2 \times log. \frac{r}{y}$. But we have just found

found that $\frac{v^2}{s^2 r} = \left(\frac{A^{n+1}}{r^n} =\right) \frac{A^2}{r}$ upon the present supposition; therefore $A^2 = \frac{v^2}{s^2}$: substitute and reduce, then $p^2 = \frac{P^2}{1 + \frac{2}{s^2} \times \log. \frac{r}{y}}$, or $p = \frac{P}{\sqrt{1 + \frac{2}{s^2} \times \log. \frac{r}{y}}}$, the equation of the curve.

Next, to find the angle described, or the position of the line joining the centre of force and the body in respect of the line CV for any given value of it. By similar triangles we have $y^2 : p^2 :: tn^2 : tv^2$, and by division,

$$y^2 - p^2 : p^2 :: vn^2 : tv^2$$

also, $y^2 : r^2 :: tv^2 : XY^2$;

exæq. $y^4 - p^2 y^2 : r^2 p^2 :: vn^2 : XY^2 :: \dot{y}^2 : \dot{z}^2$ ($\dot{z}$ being supposed $= XY$); consequently

$$\dot{z} = \frac{r p \dot{y}}{y \sqrt{y^2 - p^2}},$$ whatever be the value of n. Substitute therefore, in this equation, the several values of p found above, and there will arise the following equations:

$$1.\ \dot{z} = \pm \frac{r\sqrt{\frac{m}{m-1}} \times P y^{\frac{n-3}{2}} \dot{y}}{y \sqrt{y^{n-1} - \frac{m}{m-1} \times P^2 y^{n-2} + \frac{r^{n-1}}{m-1}}},\ m > 1.$$

$$2.\ \dot{z} = \pm \frac{r P y^{\frac{n-3}{2}} \dot{y}}{\sqrt{r^{n-1} y^2 - P^2 y^{n-1}}} = \pm \frac{r y^{\frac{n-5}{2}} \dot{y}}{\sqrt{\frac{r^{n-1}}{P^2} - y^{n-3}}},\ m = 1.$$

$$3.\ \dot{z} = \pm \frac{r\sqrt{\frac{m}{m-1}} \times P y^{\frac{n-3}{2}} \dot{y}}{y\sqrt{\frac{r^{n-1}}{1-m} - \frac{m}{1-m} \times P^2 y^{n-3} - y^{n-1}}},\ m \angle 1.$$

If $n = 1$, then by ſubſtituting, in the ſame equation, the value of p found above, we have

$$\dot{z} = \pm \frac{r P \dot{y}}{y\sqrt{1 + \frac{2}{s^2} \times log.\ \frac{r}{y} \times y^2 - P^2}}.$$ Hence

all the curves may be conſtructed.

It muſt be obſerved, that the poſitive or negative ſign takes place, according as the body aſcends from, or deſcends towards the centre.

Becauſe $p^2 = \frac{\frac{m}{m-1} \times P^2\ y^{n-1}}{y^{n-1} + \frac{r^{n-1}}{m-1}}$ in general, and at an apſe it is evident, that $p = y$; hence, in that caſe, there ariſes by reduction, the following equation; viz. $y^{n-1} - \frac{m}{m-1} P^2\ y^{n-3} + \frac{r^{n-1}}{m-1} = o$; from whence, and the proper equation for $\dot{z}$, the number and poſition of the apſides may be determined.*

It may be obſerved that the quantity under the radical in the value of $\dot{z}$ being put $= o$, gives the equation for determining the apſides.

If m be ſuppoſed greater than unity, and y infinite, then will $p = \sqrt{\frac{m}{m-1}} \times P = a$ perpendicular upon the aſymptote to the curve deſcribed

* See the note placed at the end of this Tract.

ſcribed by the body, or its diſtance from the centre of force. This expreſſion, it may be obſerved, is not affected by the value of n. Hence if the value of z be determined upon the above ſuppoſition, the aſymptotes to the trajectory may eaſily be drawn.

If m be leſs than unity, and y infinite, then $p = \frac{\sqrt{\frac{m}{1-m}} \times P}{\sqrt{-1}}$; therefore the curve has not an aſymptote. Laſtly, if $m = 1$, the perpendicular upon the aſymptote will be infinite.

In all theſe caſes the body may deſcend to the centre, if n be greater than unity; becauſe in that caſe, when $y = o$, $p = o$. But if n be leſs than unity, the body can only arrive at the centre in a ſtraight line. For the equation

$$p = \frac{\sqrt{\frac{m}{m-1}} \times P y^{\frac{n-1}{2}}}{\sqrt{y^{n-1} + \frac{r^{n-1}}{m-1}}},$$ becomes $p = \frac{m^{\frac{1}{2}} P r^{\frac{1-n}{2}}}{\sqrt{\overline{m-1} \times r^{1-n} + y^{1-n}}}$; in which caſe, when $y = o$, the value of p is poſitive, infinite, or impoſſible, unleſs P at the ſame time be equal to nothing. But it is evident that p can never be greater than y.

It will likewiſe eaſily appear, that when $n = 1$, the body may deſcend to the centre; for

for $p^2 = \dfrac{P^2}{1 + \frac{2}{s^2} \times log. \frac{r}{y}} = P^2 \div$ by an infinite quantity when $y = o$.

But if the body begin to aſcend, the greateſt height at which it can arrive may be found, by making $p = y$; at which time it comes to an apſe.

Cor. 1. If $n = o$, or the force be the ſame at all diſtances from the centre, then $p = \dfrac{\sqrt{\frac{m}{m-1}} \times Py^{-\frac{1}{2}}}{\sqrt{y^{-1} + \frac{r^{-1}}{m-1}}}$; but $m = s^2 \times \frac{n-1}{2} = -\frac{s^2}{2}$

therefore, by ſubſtitution, $p = \dfrac{sPr^{\frac{1}{2}}}{\sqrt{\overline{s^2+r^2} \times r - 2y}}$, the equation of the curve deſcribed by the body.

Likewiſe, it will eaſily appear, that $\dot{z} = \dfrac{sPr^{\frac{3}{2}}\dot{y}}{y\sqrt{-y^3 + \frac{s^2+2}{2} \times ry^2 - \frac{s^2}{2} \cdot P^2 r}}$. The equation for determining the apſides will be found to be $y^3 - \dfrac{s^2+2}{2} \times ry^2 + \dfrac{s^2}{2} \cdot P^2 r = o$. This equation has three real roots, as is evident from the latter part of the note in the propoſition: two of them are poſitive and one negative; for the laſt term of the equation is poſitive. The nega-

tive root belongs to a part of the algebraical curve whose concavity is turned from the centre of force.

Cor. 2. If $n=2$, or the force be reciprocally as the square of the distance, the value of p will become

$$1.\ p=\frac{\sqrt{\frac{m}{m-1}}\times Py}{\sqrt{y^2+\frac{r}{m-1}y}}, \qquad m>1$$

$$2.\ p=\frac{P}{r^{\frac{1}{2}}}\times y^{\frac{1}{2}}, \qquad m=1.$$

$$3.\ p=\frac{\sqrt{\frac{m}{1-m}}\times Py}{\sqrt{\frac{r}{1-m}y-y^2}}, \qquad m<1$$

And the respective values of $\dot{z}$ will be

$$1.\ \dot{z}=\pm\frac{r\sqrt{\frac{m}{m-1}}\times P\dot{y}}{y\sqrt{y^2+\frac{r}{m-1}\times y-\frac{m}{m-1}P^2}}, \qquad m>1$$

$$2.\ \dot{z}=\pm\frac{rP\dot{y}}{y\sqrt{ry-P^2}}, \qquad m=1.$$

$$3.\ \dot{z}=\pm\frac{r\sqrt{\frac{m}{1-m}}\times P\dot{y}}{y\sqrt{-\frac{m}{1-m}P^2+\frac{r}{1-m}y-y^2}}, \qquad m<1.$$

In

In a conic ſection if A and B be the tranſverſe and conjugate axes, L the *latus rectum*, y the diſtance of any point in the ſection from the focus, and p a perpendicular from thence upon a tangent to that point; then per conics $p = \frac{\frac{1}{2}By}{\sqrt{Ay \pm y^2}}$ the poſitive or negative ſign taking place according as the curve is an hyperbola or ellipſe; but in the parabola, A being infinite, y^2 will vaniſh. Hence, becauſe in this caſe $m = \frac{n-1}{2} \times s^2 = \frac{1}{2}s^2$, it is evident that the firſt equation belongs to an hyperbola, A being $= \frac{r}{m-1} = \frac{2r}{s^2-2}$, $B = 2\sqrt{\frac{m}{m-1}} \times P = \frac{2sP}{\sqrt{s^2-2}}$, and $L = \frac{B^2}{A} = \frac{4mP^2}{r} = \frac{2s^2P^2}{r}$. Likewiſe the perpendicular upon the aſymptote $= \sqrt{\frac{m}{m-1}} \times P = \frac{sP}{\sqrt{s^2-2}}$.

The ſecond is an equation of the parabola; from whence it will appear that $\frac{\frac{1}{2}B}{A^{\frac{1}{2}}} = \frac{1}{2}\sqrt{L} = \frac{P}{r^{\frac{1}{2}}}$; therefore $\frac{1}{4}L = \frac{P^2}{r}$.

The third equation belongs to an ellipſe; A being $= \frac{r}{1-m} = \frac{2r}{2-s^2}$, $B = 2\sqrt{\frac{m}{1-m}}$

 $\times P =$

$\times P = \dfrac{2\,s\,P}{\sqrt{2 - s^2}}$, and *latus rectum* $L = \dfrac{2\,s^2 P^2}{r}$

From what has been obferved above it will evidently follow, that, if the centripetal force $\propto$ [*vary as*] the fquare of the diftance from the centre reciprocally, the curve defcribed by the body will be a conic fection, or circle.

All the common properties of bodies moving in conic fections may eafily be deduced from the above equations; but that is not the intention of this Propofition.

Cor. 3. If $n=3$, the values of p found in the Prop. will become

1. $p = \dfrac{\sqrt{\frac{m}{m-1}} \times Py}{\sqrt{y^2 + \frac{r^2}{m-1}}}$, $\quad m > 1$

2. $p = \dfrac{P}{r} \times y$, $\quad m = 1$.

3. $p = \dfrac{\sqrt{\frac{m}{1-m}} \times Py}{\sqrt{\frac{r^2}{1-m} - y^2}}$, $\quad m < 1$.

And the refpective values of z will be

1. $\dot{z} = \pm \dfrac{\sqrt{\frac{m}{m-1}} \times r P \dot{y}}{y\sqrt{y^2 + \frac{r^2 - mP^2}{m-1}}} = \pm \dfrac{\sqrt{\frac{m}{m-1}} \times Pr\dot{y}}{y\sqrt{y^2 - \frac{mP^2 - r^2}{m-1}}}$,

$m > 1$.

2. $\dot{z} =$

2. $\dot{z} = \pm \frac{Pr}{\sqrt{r^2 - P^2}} \times \frac{\dot{y}}{y}$, $m = 1$.

3. $\dot{z} = \pm \frac{\sqrt{\frac{m}{1-m}} \times r P \dot{y}}{y\sqrt{\frac{r^2 - mP^2}{1-m} - y^2}}$, $m < 1$.

The firft value of $\dot{z}$, in which m is greater than unity, may be fubdivided into three others, according as $m P^2$ is greater, equal to, or lefs than r^2.

1. If $m P^2$ be greater than r^2, the equation for determining the apfides becomes $y^2 - \frac{m}{m-1} P^2 + \frac{r^2}{m-1} = 0$; wherefore $y = \sqrt{\frac{m P^2 - r^2}{m-1}}$, the curve therefore has an apfe and two infinite legs.

By taking the correct fluent it will appear, that $z = \frac{r P \sqrt{m \cdot m-1}}{m P^2 - r^2} \times$ the difference of two arcs whofe fecants are y and r, and radius $= \sqrt{\frac{m P^2 - r^2}{m-1}}$, $= \frac{\sqrt{m} \times P}{\sqrt{m P^2 - {}^2}} \times$ the difference of two arcs whofe fecants are $\frac{\sqrt{m-1} \times r y}{\sqrt{m P^2 - r^2}}$ and $\frac{\sqrt{m-1} \times r^2}{\sqrt{m P^2 - r^2}}$, and radius $= r$; hence the tra-

jectory

jectory is easily constructed, by finding any number of points at pleasure.

If $P=r$, or the body be projected at right angles to a line drawn from the centre of force, then $z=\sqrt{\frac{m}{m-1}}\times$ arch whose secant $=y$, and rad. $=r$. To construct the orbit upon this supposition; from the centre C, at the distance $CV=r$, (Fig. 2.) describe the circle VQS; take any arc VR, and draw the tangent RT; take $VQ : VR :: \sqrt{\frac{m}{m-1}} : 1 :: \sqrt{m} : \sqrt{m-1} :: s : \sqrt{s^2-1}$, and draw CQ, which produce to n; making $Cn = CT$; then n will be a point in the curve. If VQS be taken to a quadrant in the above proportion, and CS be produced indefinitely, it will be parallel to an asymptote to the curve. This is too evident to require any particular proof. From the centre C draw CP perpendicular to CL, and take it $= \sqrt{\frac{m}{m-1}}\times r = \frac{sr}{\sqrt{s^2-1}}$, and through the point P draw PL parallel to CL, and it will be an asymptote to the curve or trajectory.

The number of revolutions which the body will make, while going from an apse to an infinite distance, will evidently be equal to

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$$\frac{\sqrt{\frac{m}{m-1}} \times \text{quadrant}}{4 \times \text{quadrant}} = \tfrac{1}{4}\sqrt{\frac{m}{m-1}}.$$

2. If $m P^2 = r^2$, then $p = \dfrac{\sqrt{\frac{r^2}{m-1}} \times y}{\sqrt{y^2 + \frac{r^2}{m-1}}}$,

the equation of the hyperbolic ſpiral; the body will therefore revolve in this curve, and will come to an apſe at the centre. For at that time $y = \sqrt{\frac{mP^2 - r^2}{m-1}} = 0$. It will likewiſe appear that $\dot{z} \pm \sqrt{\frac{m}{m-1}} \times r P \times \frac{\dot{y}}{y^2}$; the correct fluent therefore gives $x = \pm\sqrt{\frac{m}{m-1}} \cdot P \times \frac{y-r}{y}$, or $z = \sqrt{\frac{m}{m-1}} \cdot P \times \frac{y-r}{y}$, when the body aſcends, and $z = \sqrt{\frac{m}{m-1}} \cdot P \times \frac{r-y}{y}$, when it deſcends. If the body be infinitely diſtant from the centre, then $z = \sqrt{\frac{m}{m-1}} \times P$. Hence if $c = 3.14159$, the number of revolutions which the body will deſcribe in aſcending to an infinite height from the diſtance r, $= \sqrt{\frac{m}{m-1}} \times P \div$

$$2cr = \sqrt{\frac{m}{m-1}} \times \frac{P}{2cr} = \frac{1}{2c\sqrt{m-1}} =$$

$\dfrac{1}{2c\sqrt{s^2 - 1}}$, for $\sqrt{m} \times P = r$. In deſcend-ing

ing to the centre, it is evident, that the number of revolutions will be infinite; for when $y = o$, $\frac{r-y}{y} = \frac{r}{o}$, is infinite. The distance of the asymptote from the centre $=$ $\sqrt{\frac{m}{m-1}} \times P = \frac{r}{\sqrt{m-1}} = \frac{r}{\sqrt{s^2-1}}$.

3, If $m\,P^2$ be less than r^2, then the value of y, when the body arrives at an apse, $=$ $\sqrt{\frac{m\,P^2 - r^2}{m-1}}$, becomes impossible; therefore upon this supposition the body can never come to an apse. But it may either descend to the centre, or go off to an infinite distance, as is evident from the equation to the curve.

Because $\dot{z} = \pm \frac{\sqrt{\frac{m}{m-1}}\, r\, P\, \dot{y}}{y\sqrt{y^2 + \frac{r^2 - m\,P^2}{m-1}}}$, by taking the fluent $z = \mp r\,P\sqrt{\frac{m}{r^2 - m\,P^2}} \times log.$

$$\frac{\sqrt{y^2 + \frac{r^2 - m^2}{m-1}} + \sqrt{\frac{r^2 - m\,P^2}{m-1}}}{y},$$

and corrected $z = \pm r\,P\sqrt{\frac{m}{r^2 - m\,P^2}} \times log.$

$$\frac{\sqrt{m\,.\,\overline{r^2 - P^2}} + \sqrt{r^2 - m\,P^2}}{\sqrt{\overline{m-1}\cdot y^2 + r^2 - m\,P^2} + \sqrt{r^2 - m\,P^2}} \times \frac{y}{r}.$$

If

If y be infinite, then $z = rP\sqrt{\frac{m}{r^2 - mP^2}} \times log.$ $\frac{\sqrt{m.\overline{r^2 - P^2}} + \sqrt{r^2 - mP^2}}{r\sqrt{m-1}}$. The body will therefore go off to an infinite diſtance in a finite number of revolutions.

But if $y = o$, the value of the fraction $\frac{\sqrt{m.\ \overline{r^2 - P^2}} \times \sqrt{r^2 - mP^2}}{\sqrt{m-1}\ y^2 + r^2 - mP^2 + \sqrt{r^2 - mP^2}} \times \frac{y}{r}$ is nothing, wherefore the body will make an infinite number of revolutions in deſcending to the centre. From the above equations the trajectory may be conſtructed.

Next, if $m = 1$, the equation of the trajectory being $p = \frac{P}{r} \times y$, the curve in which the body moves is the log. ſpiral. But $\dot{z} = \pm \frac{Pr}{\sqrt{r^2 - P^2}} \times \frac{\dot{y}}{y}$, therefore $z = \frac{Pr}{\sqrt{r^2 - P^2}} \times \log. \frac{y}{r}$ when the body aſcends, and $z = \frac{Pr}{\sqrt{r^2 - P^2}} \times \log. \frac{r}{y}$ when it deſcends; wherefore, the body can neither deſcend to the centre, nor go off to an infinite diſtance in a finite number of revolutions. If $P = r$, or the body be projected at right angles to the line drawn from the centre, it is evident that it will deſcribe a circle.

In the last case, when m is less than unity, the equation of the trajectory is $p = \frac{\sqrt{\frac{m}{1-m}} \times Py}{\sqrt{\frac{r^2}{1-m} - y^2}}$, and $\dot{z} = \pm \frac{\sqrt{\frac{m}{1-m}} \times rP\dot{y}}{y\sqrt{\frac{r^2 - mP^2}{1-m} - y^2}}$. It is evident that when $y = o$, $p = o$; the body may therefore descend to the centre; but if y be infinite, $p = \frac{\sqrt{\frac{m}{1-m}} \times P}{\sqrt{-1}}$; therefore the body cannot ascend to an infinite height. It is likewise evident from the above equation, that when y increases, p increases; but p can never exceed y, therefore when they are equal, that is, at an apse, y will be the greatest possible; but then $y = \sqrt{\frac{r^2 - mP^2}{1-m}}$. Wherefore, after the body has passed an apse, it will descend to the centre.

Because $\dot{z} = \pm \frac{\sqrt{\frac{m}{1-m}} \times rP\dot{y}}{y\sqrt{\frac{r^2 - mP^2}{1-m} - y^2}}$, the correct fluent being taken, and the equation reduced

duced we have $z = rP\sqrt{\frac{m}{r^2 - mP^2}} \times$

$$\left(\pm \log. \frac{\sqrt{\frac{r^2 - mP^2}{1-m}} - \sqrt{\frac{r^2 - mP^2}{1-m} - y^2}}{y} \right.$$

$$\left. \mp \log. \frac{\sqrt{\frac{r^2 - mP^2}{1-m}} - \sqrt{\frac{r^2 - mP^2}{1-m} - r^2}}{r} \right).$$

If $P = r$, or the body be projected from an apse, then $z = r\sqrt{\frac{m}{1-m}} \times \log. \frac{y}{r - \sqrt{r^2 - y^2}}$, and when $y = o$, the value of the fraction $\frac{y}{r - \sqrt{r^2 - y^2}}$ is infinite, as may be found either by taking the fluxions of the numerator and denominator, or by expanding $\sqrt{r^2 - y^2}$, and dividing y by the denominator; hence the body will make an infinite number of revolutions before it arrives at the centre.

The orbit may be constructed in the following manner. Let the rectangular hyperbole VA (Fig. 3.) be described, whose centre is C and vertex V; join CA, and draw the the tangent AT to the point A, and AB perpendicular to the axis VB. Let $CV = r$, $CB = x$, and $CT = y$. It is well known that the fluxion of the sector

 CVA

$CVA = \frac{r^2}{2} \times \frac{\dot{x}}{\sqrt{x^2 - r^2}}$; but $x : r :: r : y$, therefore $x = \frac{r^2}{y}$, and $\dot{x} = -\frac{r^2 \dot{y}}{y^2}$, consequently $\frac{r^2}{2} \times \frac{\dot{x}}{\sqrt{x^2 - r^2}} = -\frac{r^2}{2} \times \frac{r^2 \dot{y}}{y\sqrt{\frac{r^4}{y^2} - r^2}} = -$

$\frac{r^3 \dot{y}}{2y\sqrt{r^2 - y^2}} =$ fluxion of the sector CVA.

But in this case $\dot{z} = -\frac{\sqrt{\frac{m}{1-m}} \times r^2 \dot{y}}{y\sqrt{r^2 - y^2}}$, therefore the fluxion of the circular sector $CVY = -$

$\frac{\sqrt{\frac{m}{1-m}} \times r^3 \dot{y}}{2y\sqrt{r^2 - y^2}}$. Take $\sqrt{\frac{m}{1-m}} : 1 ::$ hyperbolic sector : circular sector VCY, and make $Cp = CT$; then is p a point in the trajectory.

From this construction it will easily appear, that the number of revolutions which the body must make before it arrives at the centre will be infinite, because the area CVA increases without limit.

Or the trajectory may be constructed in the following manner. Describe the semicircle SVD (Fig. 4).) with the radius $CV = r$; draw AB perpendicular to CD, and suppose it equal to y, and take the arc $VQ =$ the difference of

of the hyperbolic logarithms of AB and BD multiplied into $r\sqrt{\frac{m}{1-m}}$, and take $Cp = AB$; then is p a point in the trajectory, as will be evident from the equation $z = r\sqrt{\frac{m}{1-m}} \times$ log. $\frac{y}{r - \sqrt{r^2 - y^2}}$.

Becaufe the ratio of AB to BD is infinitely great when AD is evanefcent, the number of revolutions before the body arrives at the centre, muft be infinite.

Cor. 4. If $n = 4$, then, $p = \frac{\sqrt{\frac{m}{m-1}} \times P y^{\frac{3}{2}}}{\sqrt{y^3 + \frac{r^3}{m-1}}}$,

$\dot{z} = \pm \frac{\sqrt{\frac{m}{m-1}} \times r P y^{\frac{1}{2}} \dot{y}}{y\sqrt{y^3 - \frac{m}{m-1} \times P^2 y + \frac{r^3}{m-1}}}$, and $y^3 - \frac{m}{m-1} P^2 y + \frac{r^3}{m-1} = o$, is the equation for determining the apfides; where m may be greater than, equal to, or lefs than unity. The ratios of m to unity, and of P to r being given, it will be eafy to determine when all the roots of this laft equation are real, and when two of them are impoffible. If the body be projected from an apfe, or $P = r$, then all the

the

the roots are real, two being positive and one negative, which belongs to a part of the curve having its concavity turned from the centre of force.

If $n = 5$, then $p = \dfrac{\sqrt{\frac{m}{m-1}} \times P y^2}{\sqrt{y^4 + \frac{r^4}{m-1}}} =$

$\dfrac{\sqrt{m} \times P y^2}{\sqrt{m-1 \cdot y^4 + r^4}}$, $\dot{z} = \dfrac{\sqrt{\frac{m}{m-1}}\, r P y \dot{y}}{y \sqrt{y^4 - \frac{m}{m-1} P^2 y^2 + \frac{r^4}{m-1}}}$

and $y^4 - \dfrac{m}{m-1} P^2 y^2 + \dfrac{r^4}{m-1} = o$, is the equation for determining the apsides; here, likewise, m may be greater than, equal to, or less than unity. The several parts of this curve might easily be traced out when m is greater or less than unity, but notice will only be taken of that case in which $m = 1$, or the body is projected with the same velocity as it would acquire by falling from an infinite height. In this case $p = \dfrac{P}{r^2} \times y^2$, an equation to a circle, the centre of force being in the circumference, and the diameter $= \dfrac{r^2}{P}$. For, let C in the circumference of the circle AVC, be the centre of force, CA the diameter (Fig, 5.) V the point from

from which the body is projected, n any other place in the circle; draw the tangents VP, np, and the perpendicular CP, Cp, and join V, A, and n, A. Then by similar triangles $CP : CV :: CV : CA$, that is, $P : r :: r : CA = \frac{r^2}{P}$; and $Cp : Cn :: Cn : CA$; that is, $p : y :: y : \frac{r^2}{P}$, therefore, $p = \frac{P}{r^2} \times y^2$.

It will easily appear, that upon this supposition, the periodic times in different circles would be as the cubes of their diameters directly; taking it for granted that a revolution were possible.

Cor. 5. If $n = 1$, or the force be directly as the distance, then, $m = \frac{n-1}{2} \times s^2 = -s^2$;

hence because in general, $p = \frac{\sqrt{\frac{m}{m-1}} \times P y^{\frac{n-1}{2}}}{\sqrt{y^{n-1} + \frac{r^{n-1}}{m-1}}}$

therefore by substitution and reduction $p = \frac{s P r}{\sqrt{\overline{s^2+1} \times r^2 - y^2}}$, and $\dot{z} = \frac{s P r^2 \dot{y}}{y \sqrt{-y^4 + \overline{s^2+1} \,.\, r^2 y^2 - s^2 P^2 r^2}}$. The above is an equation to an ellipse, the centre of

of force being in its centre. For, if $2R =$ the transverse, and $2C =$ the conjugate axis, $y =$ the distance from the centre, and $p =$ the perpendicular upon the tangent, then $p = \frac{CR}{\sqrt{R^2 + C^2 - y^2}}$. Compare this with the above equation, and it will easily appear, that $2R = \sqrt{\overline{s^2+1} \cdot r^2 + 2sPr} + \sqrt{\overline{s^2+1} \cdot r^2 - 2sPr}$, and $2C = \sqrt{\overline{s^2+1} \cdot r^2 + 2sPr} - \sqrt{\overline{s^2+1} \cdot r^2 - 2sPr}$. The same conclusion may likewise be deduced from the equation for determining the apsides, which has two roots positive, and two equal to them and negative.

Cor, 6. If $m = 1$, then $s^2 = \frac{2}{n-1}$; which, if n be greater than 3, is less than unity, and the body in this case must fall to the centre; and the number of revolutions it will make before it arrives there, may be determined in the following manner. In this case $p = \frac{P}{r^{\frac{n-1}{2}}} \times y^{\frac{n-1}{2}} = \frac{y^{\frac{n-1}{2}}}{r^{\frac{n-3}{2}}}$ when $P = r$, or the body moves from an apse; therefore $p : y :: y^{\frac{n-3}{2}} : r^{\frac{n-3}{2}}$. But when y and p are evanescent, $r^{\frac{n-3}{2}}$ is infinitely greater than p, and consequently at that time the angle $n\,C\,p$ (Fig. 1.) will be a right angle. From the equation of the

the curve it will eaſily appear that $\frac{\dot{p}}{p} = \frac{n-1}{2} \times \frac{\dot{y}}{y}$. Let A, and a repreſent the angles deſcribed by Cp, and Cn, reſpectively ſince the body left an apſe; then, becauſe $\dot{A} : \dot{a} :: \frac{\dot{p}}{y} : \frac{\dot{y}}{y}$ * $:: \frac{n-1}{2} : 1$; $\dot{A} = \frac{n-1}{2} \times \dot{a}$, and $A = \frac{n-1}{2}a$; for A and a begin together. But $A = Q + a$ when $y = o$, or the body arrives at the centre;

C c c hence

* If a body revolve in a curve of any kind round a centre of force; to compare the angular velocity of the perpendicular upon the tangent with that of the diſtance from the centre, or radius vector.

Let PQW (Fig. 6.) be the curve in which the body moves, S the centre of force, and C the centre of curvature. Let P, Q be two points in the curve indefinitely near to each other, to which the tangents PY, Qy are drawn; let fall the perpendiculars SY, Sy, and QT, which laſt may be taken for the arch of a circle deſcribed from the center S. It is evident that the angles PSQ, PCQ are to each other as $\frac{QT}{SP} : \frac{PQ}{CP} :: \frac{SY}{SP} : \frac{SP}{CP}$ (by ſimilar triangles) $:: \frac{p}{y} : \frac{y}{CP}$. But $CP = \frac{y\dot{y}}{\dot{p}}$, and the angle $PCQ = YSy$, therefore the angle $PSQ : YSy :: \frac{p}{y} : y \div \frac{y\dot{y}}{\dot{p}} :: \frac{\dot{y}}{y} : \frac{\dot{p}}{p}$.

hence we have $a = \frac{2}{n-3} \times \mathfrak{Q} = \frac{1}{2 \times \overline{n-3}} \times C$, $\mathfrak{Q}$ being a quadrant, and $C =$ the circumference of a circle whofe radius $= r$. The number of revolutions therefore $= \frac{1}{2 \times \overline{n-3}}$.

If n be lefs than 3, s muft be greater than unity; therefore the body projected at right angles to a line drawn from the centre of force, and with a greater velocity than would make it defcribe a circle, it muft begin to afcend; and it muft ever continue rifing, as its velocity is equal to that acquired by falling from an infinite height. Becaufe $p : y :: r^{\frac{3-n}{2}} : y^{\frac{3-n}{2}}$, therefore when y is infinite, p is finite, and hence the angle pCp, at that time is a right angle. As above, $A = \frac{n-1}{2} \times a$, and $a = \mathfrak{Q} + A$, therefore $a = \frac{2}{3-n} \times \mathfrak{Q} = \frac{1}{2 . \overline{3-n}} \times C$. Hence the number of revolutions the body defcribes in afcending to an infinite height $= \frac{1}{2 \times \overline{3-n}}$.

SCHOLIUM.

Becaufe $\frac{v}{s} =$ velocity in a circle at the diftance r from the centre, and if the force $\propto$

1

$\frac{1}{y^n}$, the velocities in circles will $\propto \frac{1}{y^{\frac{n-1}{2}}}$ (*Princip.* Prop. 4.) consequently $\frac{r^{\frac{n-1}{2}}}{y^{\frac{n-1}{2}}} \times \frac{v}{s}$ = velocity in a circle at the distance y from the centre. But $\frac{Pv}{p}$ = velocity in the trajectory at the distance y; if, therefore, we make $\frac{Pv}{p} = \frac{r^{\frac{n-1}{2}}}{y^{\frac{n-1}{2}}} \times \frac{v}{s}$, and at the same time the body be supposed to arrive at an apse, in which case $p^2 = y^2 =$

$$\frac{\frac{m}{m-1} \times P^2\ y^{n-1}}{y^{n-1} + \frac{r^{n-1}}{m-1}}$$

, it would continue to move for ever in this circle. But coming to an apse, it must ascend or descend in a similar and equal curve, hence it never can arrive at the distance y from the centre, determined from the above equations, in any finite number of revolutions. Making, therefore, as above $\frac{Pv}{p} = \frac{r^{\frac{n-1}{2}}}{y^{\frac{n-1}{2}}} \times \frac{v}{s}$, we have $p^2 = P^2 s^2 \times \frac{y^{n-1}}{r^{n-1}} =$

 m

$$\frac{\frac{m}{m-1} \times P^2 y^{n-1}}{y^{n-1} + \frac{r^{n-1}}{m-1}}, \text{ hence, } s^2 = \frac{\frac{m}{m-1} \times r^{n-1}}{y^{n-1} + \frac{r^{n-1}}{m-1}}.$$

But because $p^2 = y^2 = \dfrac{\frac{m}{m-1} \times P^2 y^{n-1}}{y^{n-1} \times \frac{r^{n-1}}{m-1}}$,

$y^{n-1} + \dfrac{r^{n-1}}{m-1} = \dfrac{m}{m-1} \times P^2 y^{n-3}$; $s^2 P^2 = \dfrac{r^{n-1}}{y^{n-3}}$. But the equation for determining the apsides is $y^{n-1} - \dfrac{m}{m-1} P^2 y^{n-3} + \dfrac{r^{n-1}}{m-1} = o$, or $y^{n-1} - \dfrac{n-1}{\overline{n-1}. s^2 - 2} \times s^2 P^2 y^{n-3} + \dfrac{2 r^{n-1}}{\overline{n-1}. s^2 - 2} = o$; whence by substitution we have $y^{n-1} - \dfrac{\overline{n-1}. r^{n-1}}{\overline{n-1}. s^2 - 2} + \dfrac{2 r^{n-1}}{\overline{n-1}. s^2 - 2} = o$, or $y^{n-1} = \dfrac{n-3}{\overline{n-1}. s^2 - 2} \times r^{n-1}$, therefore $y = \overline{\dfrac{n-3}{\overline{n-1}. s^2 - 2}}\Big|^{\frac{1}{n-1}} \times r = \overline{\dfrac{n-3}{2m-2}}\Big|^{\frac{1}{n-1}} \times r$,

$\times\, r$, becaufe $\frac{2m}{n-1} = s^2$. It is evident from infpection, that n muft be greater than 3 and m greater than unity; the force therefore muft vary in an higher proportion than the cube of the diftance inverfely. If the body defcend from the point v, then $s^2 = \frac{r^{n-1}}{P^2 \; y^{n-3}}$, muft be greater than unity. If it afcend, then $n-3$ muft be greater than $\overline{n-1} \times s^2 - 2$, and therefore s^2, and confequently s, lefs than unity.

From the above equations and obfervations, we have the following conftruction. (Fig. 7.) Let C be the centre of force, V the point from which the body is projected in the direction VP, which makes an acute angle with CV, and with a velocity greater than would make it move in the circle vzu if projected at right angles. With the centre C and radius $Ca =$

$$\overline{\frac{n-1}{\overline{n-1}\,.\,s^2 - 2}}\Bigg|^{\frac{1}{n-1}} \times r$$

defcribe the circle abd, and from C upon VP let fall the perpendicular CP, making it equal to $\frac{r^{\frac{n-1}{2}}}{s \times Ca^{\frac{n-3}{2}}}$. Then, from what has been determined in this Scholium, it will be evident, that the body will move in the

the curve VW, to which VP is a tangent, continually defcending towards the circle abd, but will never arrive at it in any finite number of revolutions. This circle is therefore an afymptote to the trajectory.

In the fame manner, if s be lefs than unity, or the velocity with which the body is projected in a line VT, which makes an acute angle with VA, be lefs than the velocity of a body in the circle VUZ; then with the centre C and radius $CA = \overline{\frac{n-3}{\overline{n-1}\,.\,s^2-2}}\Big|^{\frac{1}{n-1}} \times r$ defcribe the circle ABD, and from C upon TV produced let fall the perpendicular CP, which make equal to $\dfrac{r^{\frac{n-1}{2}}}{s \times CA^{\frac{n-3}{2}}}$; then the body will continually afcend from the centre, but will never arrive at the circle ABD. This circle, therefore, is likewife an afymptote to the curve in which the body moves,

Hence, if a body be projected from any point, and defcend towards the centre, the velocity with which it is projected muft be greater than either that which it would acquire in falling from an infinite height to that point, or than that of a body defcribing the circle at the

the diſtance of that place from the centre of force. If it aſcend, the velocity muſt be greater than that acquired by deſcending from an infinite height, but leſs than that of a body in a circle at that diſtance. Within theſe limits the conſtruction is general.

PROPOSITION II.

THE ſame things being given as in the laſt propoſition; to determine the velocity and time correſponding to any given diſtance of the body from the centre of force.

Let the velocities of bodies in a circle at the diſtance r in the curve, at V and n, be $=$ V, v and $\acute{v}$ reſpectively (Fig. 1.); then $\acute{v} = \frac{Pv}{p}$. If therefore the ſeveral values of p, depending upon the different values of m, be ſubſtituted, we ſhall have

$$1.\ \acute{v} = \frac{v\sqrt{y^{n-1} + \frac{r^{n-1}}{m-1}}}{\sqrt{\frac{m}{m-1} \times \frac{y^{n-1}}{2}}} = v\sqrt{\frac{\overline{m-1} \times y^{n-1} + r^{n-1}}{m \times y^{n-1}}},$$

m being greater than 1.

2.

$$2.\ \acute{v} = v\sqrt{\frac{r^{n-1}}{y^{n-1}}} \qquad m = 1.$$

$$3.\ \acute{v} = \frac{v\sqrt{\frac{r^{n-1}}{1-m} - y^{n-1}}}{\sqrt{\frac{m}{1-m}} \times y^{\frac{n-1}{2}}} = v\sqrt{\frac{r^{n-1} - \overline{1-m}.y^{n-1}}{m.y^{n-1}}}$$

m being less than 1.

$$4.\ \acute{v} = \frac{V\sqrt{r^{n-1} - y^{n-1}}}{\sqrt{\frac{n-1}{2}} \times y^{\frac{n-2}{2}}},\ m = o, \text{ therefore}$$

$v = o$.

If $n = 1$, then $\acute{v} = v\sqrt{1 + \frac{2}{s^2} \times log. \frac{r}{y}}$.

In the 4th value of $\acute{v}$, $m = o = s^2 \times \frac{n-1}{2}$, $v : V : : s : 1$; therefore $sV = v$; hence $\frac{m}{1-m} = \frac{s^2 \times \overline{n-1}}{2 - s^2 \times \overline{n-1}}$, and $\frac{v}{\sqrt{\frac{m}{1-m}}} = \frac{V}{\sqrt{\frac{n-1}{2}}}$ s being $= o$, therefore the 4th. form is evident from the 3d. Because $m = s^2 \times \frac{n-1}{2}$, and $s^2 = \frac{v^2}{V^2}$, therefore $m = \frac{v^2}{V^2} \times \frac{n-1}{2}$; which value of m being substituted for it in the first equation gives, when reduced

$\acute{v} =$

$$\acute{v} = \sqrt{v^2 - 2V^2 \times \frac{y^{n-1} - r^{n-1}}{n-1 \times y^{n-1}}} =$$

$$\sqrt{v^2 + 2V^2 \times \frac{r^{n-1} - y^{n-1}}{n-1 \times y^{n-1}}}.$$ Let g = force of gravity, and ſuppoſe the force at V, or at the diſtance r from the centre of force : force of gravity (g) :: l : 1, then lg = force at V, meaſured by the velocity in the time (1); hence, $\frac{V^2}{r} = lg$, or $V^2 = lgr$, therefore by ſubſtitution $\acute{v} = \sqrt{v^2 - 2lgr \times \frac{y^{n-1} - r^{n-1}}{n-1 \times y^{n-1}}} =$

$$\sqrt{v^2 + 2lgr \times \frac{r^{n-1} - y^{n-1}}{n-1 \times y^{n-1}}}.$$ When $n=1$, if the above value of s^2 be ſubſtituted we have

$$v = \sqrt{v^2 + 2lgr \times log.\frac{r}{y}} = \sqrt{v^2 - 2lgr \times log.\frac{y}{r}}.$$

Becauſe P does not enter into the values of $\acute{v}$, it is evident that the velocity of the body will be the ſame, whether it move in a curve line, or directly to or from the centre; the diſtance of y being the ſame in both caſes.

By the help of the 4th. theorem, it will be eaſy to determine how far a body muſt fall towards the centre, to acquire the velocity it has in the curve. For the value of $\acute{v}$ there

given being put $= v = sV$, we ſhall have by reduction $y = r \times \overline{\frac{2}{s^2 \times \overline{n-1} + 2}}\Big|^{\frac{1}{n-1}}$ and the ſpace deſcended $r - y = r \times$

$$\frac{\overline{s^2 \times \overline{n-1} + 2}\Big|^{\frac{1}{n-1}} - 2^{\frac{1}{n-1}}}{\overline{s^2 \times \overline{n-1} + 2}\Big|^{\frac{1}{n-1}}}.$$

If $n = 2$, then $r - y = \frac{s^2}{s^2 + 2} \times r$, which is general for all the conic ſections. In the hyberbola, the tranſverſe axis $= \frac{2r}{s^2 - 2} =$, ſuppoſe, to A (ſee Cor. 2. Prop. 1.), therefore $s^2 = \frac{2A + 2r}{A}$; hence by ſubſtitution $r - y = \frac{A + r}{2A + r} \times r$.

In the parabola, $r - y = \frac{s^2}{s^2 + 2} = \frac{1}{2} r$, s^2 being in this caſe $= 2$,

In the ellipſis, $r - y = \frac{Ar}{2A - r} \times r$, the tranſverſe axis being $\frac{2r}{2 - s^2} = A$.

If

If the body be ſuppoſed to move in a circle, and therefore $s = 1$, then $r - y =$

$$\frac{\overline{n+1}|^{\frac{1}{n-1}} - 2^{\frac{1}{n-1}}}{\overline{n+1}|^{\frac{1}{n-1}}} \times r = \left(1 - \overline{\frac{2}{n+1}}\Big|^{\frac{1}{n-1}}\right) \times r.$$

If $n = 2$, then $r - y = \frac{1}{3} r$.

If it be required to find how high a body will aſcend, if projected upwards with the velocity it has in the curve; or how far it muſt fall externally, to acquire that velocity, put the value of $\acute{v}$, in the third theorem, $= o$, then y^{n-1}

$$= \frac{r^{n-1}}{1-m} = \frac{2\, r^{n-1}}{2 - s^2 \cdot \overline{n-1}}, \text{ and } y = r \times$$

$$\overline{\frac{2}{2 - s^2 \cdot \overline{n-1}}}\Big|^{\frac{1}{n-1}}.$$

If $n = 2$, then $y = r \times \frac{2}{2 - s^2} = A$, the greater axis of the ellipſe.

If $s = 1$, then $y = r \times \frac{2}{2 - s^2} = 2r$.

Laſtly, when m is greater than unity, it may be determined by the firſt theorem, what proportion the velocity in the curve bears to that velocity, towards which it continually approaches as the body recedes indefinitely from the centre. For, if y be ſuppoſed infinite,

 then

then $\acute{v}$ will become $= \dfrac{v}{\sqrt{\dfrac{m}{m-1}}} = \dfrac{v}{\sqrt{\dfrac{s^2 \cdot \overline{n-1}}{s^2 . \overline{n-1} - 2}}}$

Hence the velocity in the curve : velocity at an infinite diſtance : : $v : \dfrac{v}{\sqrt{\dfrac{s^2 \cdot \overline{n-1}}{s^2 \cdot \overline{n-1} - 2}}}$: :

$\sqrt{\dfrac{s^2 \times \overline{n-1}}{s^2 \cdot \overline{n-1} - 2}} : 1$. In the hyperbola, that is, when $n = 2$, the proportion will be $\sqrt{\dfrac{s^2}{s^2 - 2}} : 1 :: \sqrt{A + r} : \sqrt{r}$; A being equal the tranſverſe axis.

Let $1 =$ time of moving from V to n, $x =$ curve line Vn (Fig. 1.); then $\sqrt{y^2 - p^2} : y :: \dot{y} : \dot{x} = \dfrac{y \dot{y}}{\sqrt{y^2 - p^2}}$. But $\acute{v} : \dot{x} :: 1 : \dot{t} = \dfrac{\dot{x}}{\acute{v}}$

$= \dfrac{p \dot{x}}{Pv}$, becauſe $\acute{v} = \dfrac{Pv}{p}$; therefore $\dot{t} = \pm$

$\dfrac{p y \dot{y}}{P v \sqrt{y^2 - p^2}}$, in which expreſſion, if the ſeveral values of p be ſubſtituted, we ſhall have

$$1.\quad \dot{t} = \pm \frac{\sqrt{\frac{m}{m-1}} \times y^{\frac{n-1}{2}} \dot{y}}{v \sqrt{y^{n-1} - \frac{m}{m-1} P^2 y^{n-3} + \frac{r^{n-1}}{m-1}}},$$

m being greater than 1. 2.

$$2.\quad \dot t = \pm \frac{y^{\frac{n-1}{2}}\,\dot y}{v\sqrt{r^{n-1} - P^2\, y^{n-3}}}, \qquad m=1.$$

$$3.\quad \dot t = \pm \frac{\sqrt{\frac{m}{1-m}} \times y^{\frac{n-1}{2}}\,\dot y}{v\sqrt{\frac{r^{n-1}}{1-m} - \frac{m}{1-m}P^2\, y^{n-3} - y^{n-1}}},$$

m being lefs than 1.

$$4.\quad \dot t = \pm \frac{\sqrt{\frac{n-1}{2}} \times y^{\frac{n-1}{2}}\,\dot y}{V\sqrt{r^{n-1} - y^{n-1}}}, \quad P = v,$$

$$v = o \quad \text{and} \quad m = o.$$

The 4th. theorem is found by making the fame fubftitution as before.

Cor. 1. If $n=2$, the feveral values of $\dot t$ will become

$$1.\quad \dot t = \pm \frac{\sqrt{\frac{m}{m-1}} \times y\dot y}{v\sqrt{y^2 \times \frac{r}{m-1}y - \frac{m}{m-1}P^2}},$$

m being greater than 1.

$$2.\quad \dot t = \pm \frac{y\dot y}{v\sqrt{ry - P^2}}, \qquad m = 1.$$

$$3.\quad \dot t = \pm \frac{\sqrt{\frac{m}{m-1}} \times y\dot y}{v\sqrt{-\frac{m}{1-m}P^2 \times \frac{r}{1-m}y - y^2}},$$

m being lefs than 1.

4,

$$4.\ \dot{t} = \pm \frac{\sqrt{\frac{1}{6}} \times y\dot{y}}{V\sqrt{ry - y^2}} = \frac{\sqrt{\frac{1}{2}} \times y\dot{y}}{\sqrt{lgr} \times \sqrt{ry-y^2}},$$

$$P = o,\quad m = o.$$

The fluents in all these cases may be found by circular arcs and logarithms.

The correct fluent being taken for the 4th. form, gives $t = \frac{1}{V\sqrt{2}} \times \left(\sqrt{ry - y^2} + arc\right)$ whose versed sine $= r - y$ and rad. $= \frac{1}{2}r = \frac{1}{\sqrt{2lgr}} \times \left(\sqrt{ry - y^2} + arc\right)$, versed sine $= r - y$ and rad. $= \frac{1}{2}r$; and when the body is fallen to the centre, then $t = \frac{1}{\sqrt{2lgr}} \times \frac{pr}{2}$; p. being $= 3{\cdot}141592$.

Cor. 2. If $n = 3$, the values of $\dot{t}$ will become,

$$1.\ \dot{t} = \pm \frac{\sqrt{\frac{m}{m-1}} \times y\dot{y}}{v\sqrt{y^2 + \frac{r^2 - mP^2}{m-1}}},\qquad m > 1.$$

$$2.\ \dot{t} = \pm \frac{y\dot{y}}{v\sqrt{r^2 - P^2}}\qquad m = 1.$$

$$3.\ \dot{t} = \pm \frac{\sqrt{\frac{m}{1-m}} \times y\dot{y}}{v\sqrt{\frac{r^2 - mP^2}{1-m} - y^2}},\qquad m < 1.$$

4.

$$4, \ \dot{t} = -\frac{y\dot{y}}{V\sqrt{r^2-y^2}} = -\frac{y\dot{y}}{\sqrt{lgr}\times\sqrt{r^2-y^2}}$$

$$P = o, \ m = o.$$

Hence by taking the correct fluents there will arise

$$1. \ t. = \frac{1}{v}\sqrt{\frac{m}{m-1}} \times \left(\pm \sqrt{y^2 + \frac{r^2 - mP^2}{m-1}} \right.$$
$$\left. \mp \sqrt{\frac{m}{m-1}} \times \sqrt{r^2 - P^2} \right), \ m > 1.$$

$$2. \ t = \frac{1}{2v} \times \frac{\pm y^2 \mp r^2}{\sqrt{r^2 - P^2}}, \qquad m = 1.$$

$$3, \ t = \frac{1}{v}\sqrt{\frac{m}{1-m}} \times \left(\mp \sqrt{\frac{r^2 - mP^2}{1-m} - y^2} \right.$$
$$\left. \pm \sqrt{\frac{m}{1-m}} \times \sqrt{r^2 - P^2} \right), \ m < 1.$$

$$4, \ t = \frac{1}{V} \times \sqrt{r^2 - y^2} = \frac{r}{V} = \frac{r}{\sqrt{lgr}} =$$
$$\frac{r^{\frac{1}{2}}}{\sqrt{lg}}, \text{ when } y = o, \ m = o.$$

Consequently at the end of any given time, the place of the body may be found. For, from the equations given above, the value of y may be found if t be known, and y being known, z, or the arc $V\Upsilon$ will be given.

If the time of moving over any given space in a right line directly from, or towards the centre

centre be required, it will immediately be found by making $P = 0$ in the three first of the above theorems.

PROPOSITION III.

IF a body be acted upon by two forces tending to the same centre, which vary as the nth. and the qth. powers of the distance reciprocally; it is required to determine the equation of the orbit it will describe, &c.

Suppose the whole force acting upon the body, at the distance y from the centre, to be $= \frac{A^{n+1}}{y^n} + \frac{B^{q+1}}{y^q}$; hence, by proceeding as in the first Proposition, we shall have $\frac{P^2 v^2}{2 p^2} - \frac{v^2}{2} = \frac{A^{n+1}}{n-1 \times r^{n-1}} \times \frac{r^{n-1} - y^{n-1}}{y^{n-1}} + \frac{B^{q+1}}{q-1 \,.\, r^{n-1}} \times \frac{r^{q-1} - y^{q-1}}{y^{q-1}}$. Let $\frac{2 m B^{q+1}}{q-1 \,.\, r^{q-1}} = v^2$, then there arises $\frac{P^2}{p^2} - 1 = \frac{r^{n-1} - y^{n-1}}{m \times y^{n-1}} + \frac{r^{q-1} - y^{q-1}}{m \times y^{q-1}}$. Hence by reduction it will appear

pear that

$$p^2 = \frac{m\dot{m} P^2 y^{n-1}}{\overline{\dot{m}m - m - \dot{m}} \times y^{n-1} + mr^{q-1} y^{n-q} + \dot{m} r^{n-1}} =$$

$$\frac{m\dot{m} P^2 y^{q-1}}{\overline{\dot{m}m - m - \dot{m}} \times y^{q-1} + \dot{m} r^{n-1} y^{q-n} + m r^{q-1}}.$$

Suppose $\frac{B^{q+1}}{r^q} = \frac{A^{n+1}}{r^n}$, then since $\frac{2\,m\,A^{n+1}}{\overline{n-1} \times r^{n-1}}$

$= (v^2 =)\ \frac{2\,\dot{m}\,B^{q+1}}{\overline{q-1} \times r^{q-1}}$; $\frac{m\,A^{n+1}}{n-1} =$

$\frac{c\,\dot{m}\,A^{n+1} \times r^{q-n}}{\overline{q-1} \times r^{q-n}}$, or, $\frac{m}{n-1} = \frac{c\,\dot{m}}{q-1}$; hence

$\dot{m} = \frac{\overline{q-1} \times m}{c \times \overline{n-1}}$. If therefore this value of $\dot{m}$, be substituted in the above value of p^2, there will arise for the general equation of the curve

$$p^2 = \frac{m P^2 y^{n-1}}{r^{n-1} + c \times \frac{n-1}{q-1} \cdot r^{q-1} y^{n-q} + \overline{m - 1 - c \times \frac{n-1}{q-1}} \cdot y^{n-1}}.$$

If p be supposed $= y$, then the equation for determining the distance of the apsides from the centre of force will become $y^{n-1} +$

$$\frac{c \times \overline{n-1}\ r^{q-1}}{\overline{m-1} \times \overline{q-1} - c \times \overline{n-1}}\, y^{n-q}$$

$$-\frac{m\times\overline{q-1}\times P^2}{\overline{m-1}\times\overline{q-1}-c\times\overline{n-1}}\,y^{n-3}$$

$$+\frac{\overline{q-1}\times r^{n-1}}{\overline{m-1}\times\overline{q-1}-c\times\overline{n-1}}=o.$$

The value of $\dot{z}$ will be found by an eaſy ſubſtitution.

After the ſame manner the equation of the curve, &c. &c. may be found, if three or more forces act upon a body towards the ſame centre.

Cor. If $n=2$, $q=-1$, $r=P$, and the force $\frac{B^{q+1}}{y^q}$, be ſuppoſed to act from the centre, or, which is the ſame thing, $-c$ be put for $+c$; then the equation for determining the diſtance of the apſides from the centre will become $y^4-\frac{2+c-2m}{c}r^2y^2+\frac{2r^3}{c}y-\frac{2mr^4}{c}=o$. It is evident that one of the values of y will be $=r$, and the equation given above being divided by $y-r$, the quotient will be $y^3+ry-\frac{2-2m}{c}\times r^2y+\frac{2m}{c}r^3=o$; by ſolving which equation, the diſtance of the other apſe from the centre may be determined.

If

If it be required to exterminate m, we have $\frac{v^2}{s^2} \times \frac{1}{r} = \frac{A^{n+1}}{r^n} + \frac{B^{q+1}}{r^q}$ (Propofition I.) or $v^2 = s^2 \times \left(\frac{A^{n+1}}{r^{n-1}} + \frac{B^{q+1}}{r^{q-1}}\right) = \frac{2\ m\ A^{n+1}}{\overline{n-1} \times r^{n-1}}$;

and, by this Propofition, $B^{q+1} = \frac{cA^{n+1}}{r^{n-q}}$, therefore $s^2 \times \overline{1+c} = \frac{2\ m}{n-1}$, or $m =$ $\frac{s^2 \times \overline{n-1} \times \overline{1+c}}{2} = \frac{s^2 \times \overline{1-c}}{2}$ in this Cor. wherefore, by fubftituting this value in the above equation, we have $y^3 + r\,y^2 - \frac{2 - s^2 \times \overline{1-c}}{c} r^2\,y$ $+ \frac{s^2 \times \overline{1-c}}{c} r^3 = o$. But $\dot{z} = \frac{r\,p\,\dot{y}}{y\sqrt{y^2 - p^2}} =$

$$\frac{\sqrt{2\,m} \times r^3\,\dot{y}}{y\sqrt{c\,y^4 - \overline{2+c-2m} \times r^2\,y^2 + 2\,r^3\,y - 2\,m\,r^4}} =$$

$$\frac{s\sqrt{1-c} \times r^3\,\dot{y}}{y\sqrt{c\,y^4 - \overline{2+c-s^2 \times \overline{1-c}} \times r^2 y^2 + 2r^3 y - s^2 \times \overline{1-c}.r^4}};$$

if the fluent therefore be taken, when $y =$ the diftance of the other apfe from the centre, the arc defcribed in paffing from one apfe to another,

ther, and conſequently the *motion* of the apſides will be found, whatever be the form of the orbit. Henee it is evident, that if s and c be given, the eccentricity of the orbit and the motion of the apſides may be calculated.

PROPOSITION IV.

THE centripetal force being reciprocally as the nth. power of the diſtance from a plane parallel to the horizon, and the direction and velocity of a body at any point being given; it is required to determine the nature of the curve it will deſcribe.

Let $a =$ diſtance of the point at which the body is projected from the horizontal plane, $b =$ velocity parallel to, and $c =$ velocity perpendicular to the plane, $x =$ any abſciſſa, $y =$ the correſponding ordinate, and z the curve deſcribed; then $\dot{x} : \dot{z} :: b : \frac{b\dot{z}}{\dot{x}} =$ velocity of the body in the curve. The force in direction of the ordinate is = the ſquare of the velocity divided by $\frac{1}{2}$ chord of curvature perpendicular to the horizon, or paſſing through the centre of force. But $\frac{1}{2}$ chord of curvature when $\dot{x}$ is conſtant, which is the

caſe

case at present, $= -\frac{\dot{z}^2}{\ddot{y}}$; therefore the centripetal force $= \frac{b^2\,\dot{z}^2}{\dot{x}^2} \div -\frac{\dot{z}^2}{\ddot{y}} = -\frac{b^2\,\ddot{y}}{\dot{x}^2} = $, suppose, to $\frac{A^{n+1}}{y^n}$. Multiply both sides of the equation by $\dot{y}$, and take the fluents, then $\frac{b^2}{2} \times \frac{\dot{y}^2}{\dot{x}^2} = \frac{A^{n+1}}{\overline{n-1} \times y^{n-1}}$. But $\dot{x} : \dot{y} :: b : c$, or $\frac{\dot{y}^2}{\dot{x}^2} = \frac{c^2}{b^2}$, when $y = r$, therefore the fluents corrected become $\frac{c^2}{2} - \frac{b^2}{2} \times \frac{\dot{y}^2}{\dot{x}^2} = \frac{A^{n+1}}{n-1} \times \frac{y^{n-1} - r^{n-1}}{r^{n-1} \times y^{n-1}}$; which gives

$$\dot{x} = \frac{b\sqrt{\overline{n-1}} \times r^{\frac{n-1}{2}} . y^{\frac{n-1}{2}}\dot{y}}{\sqrt{\overline{n-1}\,c^2\,r^{n-1} - 2\,A^{n+1}\,y^{n-1} + 2\,A^{n+1}\,r^{n-1}}}.$$

But in Prop. I. it was found, that if a body descended from an infinite height, and was acted upon by a force $= \frac{A^{n+1}}{y^n}$, the square of the velocity acquired at the distance r was $= \frac{2\,A^{n+1}}{\overline{n-1} \times r^{n-1}}$; let therefore $\frac{2\,m\,A^{n+1}}{\overline{n-1} \times r^{n-1}}, = c^2$,

and

and then $A^{n+1} = \frac{\overline{n-1} \times c^2 r^{n-1}}{2m}$. Hence, by subſtitution and reduction, $\dot{x} = \frac{b}{c} \times$

$$\frac{\sqrt{m} \times y^{\frac{n-1}{2}} \dot{y}}{\sqrt{\overline{m-1} \times y^{n-1} + r^{n-1}}};$$

from whence the relation of x and y may be determined.

Let $V =$ velocity of a body in a circle at the diſtance r from the centre of force, and which is acted upon by the ſame force as that which tends towards the plane at the ſame diſtance from it; then $\frac{V^2}{r} = \frac{A^{n+1}}{r^n}$, or $A^{n+1} = V^2 \times r^{n-1}$; from whence, and the equation above, viz. $A^{n+1} = \frac{\overline{n-1} \times c^2 r^{n-1}}{2m}$, it will eaſily appear, that $c = \frac{\sqrt{2m} \times V}{\sqrt{n-1}}$; therefore the above equation becomes $\dot{x} = \frac{b\sqrt{n-1}}{V \times \sqrt{2}} \times$

$$\frac{y^{\frac{n-1}{2}} \dot{y}}{\sqrt{\overline{m-1} \times y^{n-1} + r^{n-1}}}.$$

Cor. 1. If c, and conſequently $m = o$, or, which is the ſame thing, if the body be projected parallel to the horizon, then $\dot{x} =$

b

$$\frac{b\sqrt{n-1}}{V \times \sqrt{2}} \times \frac{y^{\frac{n-1}{2}}\dot{y}}{\sqrt{r^{n-1} - y^{n-1}}}.$$

COR. 2. If $n = 3$, then the laſt equation in the propoſition becomes $\dot{x} = \frac{b}{v} \times \frac{y\dot{y}}{\sqrt{\overline{m-1} \times y^2 + r^2}}$. The fluent therefore being taken and corrected, by ſuppoſing x and y to begin together, we have $x = \frac{b}{v} \times \frac{\overline{\overline{m-1} \times y^2 + r^2}|^{\frac{1}{2}} - r}{m-1}$; therefore, by reduction, $y^2 = \overline{m-1} \times \frac{V^2}{b^2}x^2 + \frac{2V}{b}rx$ $= \frac{2V}{b}rx - \overline{1-m} \times \frac{V^2}{b^2}x^2$, an equation to a conic ſection; which will be an hyperbola, parabola to ellipſis, according as m is greater, equal to, or leſs than unity; that is, according as the velocity with which the body is projected in a direction perpendicular to the horizon, is greater, equal to, or leſs than that acquired by falling from an infinite height.

If $\overline{1-m} \times \frac{V^2}{b^2} = 1$, or $\overline{1-m} \times V^2 = b^2$, then the equation becomes $y^2 = \frac{2r}{\sqrt{1-m}} \times x - x^2$; therefore the curve is a circle, whoſe radius $= \frac{r}{\sqrt{1-m}}$. But $V^2 r^{n-1} = \frac{\overline{n-1} \times c^2 r^{n-1}}{2m}$,

therefore

therefore $m = \frac{\overline{n-1} \times c^2}{2\,V^2} = \frac{c^2}{V^2}$ when $n = 3$;

hence the radius of the circle $= \frac{r\,V}{\sqrt{V^2 - c^2}}$. In the same manner it will appear, that the semi-transverse and conjugate axes of the hyperbola will be $= r \times \frac{b\,V}{c^2 - V^2}$ and $r \times \frac{V}{\sqrt{c^2 - V^2}}$ and of the ellipsis, $r \times \frac{b\,V}{c^2 - V^2}$ and $r \times \frac{V}{\sqrt{V^2 - c^2}}$; and if the hyperbola be rectangular, its semi-axes $= r \times \frac{V}{\sqrt{c^2 - V^2}}$.

Cor. 3. If $n = 2$, the equation becomes

$$\dot{x} = \frac{b}{V\sqrt{2}} \times \frac{y^{\frac{1}{2}}\,\dot{y}}{\sqrt{r - \overline{1-m} \times y}} =$$

$$\frac{b}{V\sqrt{\overline{1-m} \times 2}} \times \dot{y}\sqrt{\frac{y}{\frac{r}{1-m} - y}}.$$

But $\dot{x} = \dot{y}\sqrt{\frac{y}{\frac{r}{1-m} - y}}$ is the equation of a cycloid, the diameter of whose generating circle $= \frac{r}{1-m} = r \times \frac{2\,V^2}{2\,V^2 - c^2}$; m being

=

$= \frac{c^2}{2\,V^2}$. If therefore $b^2 = 2\,V^2 \times \overline{1-m} = 2\,V^2 - c^2$, the curve will be a cycloid. Or if the value of x, in this cycloid, be taken to the correſponding value of x in the curve deſcribed, as $V\sqrt{2 \times \overline{1-m}}$ to b, the curve may be eaſily conſtructed.

Cor. 4. It was found above that $\frac{b^2}{2} \times \frac{\dot{y}^2}{\dot{x}^2} = \frac{A^{n+1}}{\overline{n-1} \times y^{n-1}}$, and at the vertex of the curve $\dot{y} = o$, therefore the correct fluent becomes $\frac{b^2}{2} \times \frac{\dot{y}^2}{\dot{x}^2} = A^{n+1} \times \frac{d^{n-1} - y^{n-1}}{\overline{n-1}\, d^{n-1}\, y^{n-1}}$, d being the value of y when $\dot{y} = o$. If therefore $n = o$, then $\frac{b^2}{2} \times \frac{\dot{y}^2}{\dot{x}^2} = A \times \frac{d^{-1} - y^{-1}}{-d^{-1} \times y^{-1}}$, by reduction $\dot{x} = \frac{b}{\sqrt{2\,A}} \times \frac{-\dot{y}}{\sqrt{d-y}}$; hence $x = \frac{b}{\sqrt{2\,A}} \times \frac{\overline{d-y}|^{\frac{1}{2}}}{\frac{1}{2}} = \frac{b}{\sqrt{\frac{1}{2}\,A}} \times \overline{d-y}|^{\frac{1}{2}}$, making $x = o$, when $y = d$. The curve therefore is a parabola, whoſe axis is perpendicular to the plane, latus rectum $= \frac{b^2}{\frac{1}{2}\,A}$ and force $= A$, meaſured by the velocity generated in the time (1).

NOTE.

(Referred to in page 375.)

Let $VABD$ (Fig. 8.) be a trajectory described by a body round a centre of force C, V an apse, and A the next following one; V being at a greater distance from the centre than A. It is evident, that if the body were projected from A, at right angles to CA, and with the same velocity it had when it arrived there, it would accurately describe the arch AV, and have the same velocity at V that it first begun with. For during the time of moving over any particle of the curve, the force acting upon the body, and the direction of the force are the same in both cases; hence the conclusion is clear. But if the body, instead of moving towards V, be projected in a contrary direction, at right angles to AC, and with the same velocity, an arch AB, equal and similar to AV, will be described; B being an apse, and $CB = CV$. Hence in the above equation y can have but two different values; but as these *may* lie in opposite directions, two may be positive, and two equal to them and negative. The other roots, if any, must either be impossible, or relate to such parts of the algebraical curve as have their concavity turned from the centre of force, or such parts as are separated from that part in which the body moves; that is, it cannot be a curve of continued curvature, as that *must be* in which the body moves.

The same conclusion may be deduced immediately from the nature of the equation found above for determining the

the apſides. For making the equation of limits $= o$, we have $y = \pm P \times \sqrt{\frac{m}{m-1} \times \frac{n-3}{n-1}}$. Whence it is evident, that there can be no more than four roots, two poſitive and two negative. But to diſcover in every caſe the number of poſſible roots is a problem of conſiderable difficulty. *Dr. Waring* has pointed out the method of doing this (*Meditationes Algebraicæ Prob.* 14,); but as his manner of writing is in general very conciſe, an eaſy inveſtigation of the ſeveral concluſions there deduced may not be improper in this place.

It is well known, that if by varying the coefficients of an equation two roots become equal, the next inſtant they will be impoſſible, and immediately before becoming equal they will be real and unequal.

This being granted, let it be propoſed to find the number of poſſible roots in the equation $x^n - A x^m - B = o$, which is an equation of the ſame kind with that for determining the apſides. Firſt, find the equation of limits, and make it $= o$, viz. $n x^{n-1} - m A x^{n-1} = o$, then $x = \overline{\frac{m}{n}}\Big|^{\frac{1}{n-m}} \times A^{\frac{1}{n-m}}$; hence x has two values, if n and m be both even numbers, and $- A$ a negative number; wherefore the number of real roots in the given equation cannot exceed four.

Multiply the firſt equation by n, and the ſecond by x, and take the difference of the products, then $\overline{m-n} \times A x^m - n B = o$; from whence $x = \overline{\frac{n}{m-n}}\Big|^{\frac{1}{m}} \times \overline{\frac{B}{A}}\Big|^{\frac{1}{m}}$, which will give two other limits, if $- B$ be poſitive, and the reſt as above.

If the given equation have two equal roots, they will coincide both with the firſt and ſecond values of x juſt

 found

found; therefore theſe values muſt be equal to each other; and converſely, if theſe values be equal, the given equation muſt have two equal roots; and if the conditions above mentioned take place, viz. that n, and m, be both even numbers, $-A$ negative, and $-B$ poſitive, then there will be two pairs of equal roots. Make them equal to each other, then by reduction it will eaſily appear that $\frac{\overline{m-n}|^{n-m}}{n^{n-m}} \times A^n - \frac{n^m}{m^m} \times B^{n-m} = o$; hence, by making this expreſſion poſitive, or negative, according to circumſtances, the number of poſſible roots may be obtained.

1. If n be an even number, and $-B$ negative, it is evident that the equation has two real roots. If n be even, and m odd, and $-B$ affirmative, and at the ſame time $\frac{\overline{m-n}|^{n-m}}{n^{n-m}} \times A^n - \frac{n^m}{m^m} \times B^{n-m}$ be negative, then there will be two poſitive roots; otherwiſe uone. For the firſt part of the above expreſſion is in this caſe negative, and the other part poſitive; but the firſt part muſt be greater than the ſecond, if the roots be real; becauſe if A vaniſh, all the roots are impoſſible; hence the concluſion is clear.

Let n, and m, be even numbers, and $-A$, and $-B$, poſitive quantities; it is evident that the equation can have no real roots; for in this caſe no quantity ſubſtituted for x can make the reſult $= o$. But if $-B$ be affirmative, and $-A$ negative, and at the ſame time $\frac{\overline{m-n}|^{n-m}}{n^{n-m}} \times A^n - \frac{n^m}{m^n} \times B^{n-m}$ be affirmative, then there will be four real roots, otherwiſe none. For, from what has been ſaid above, there will be two pairs of equal roots when the above

above expression $= o$, wherefore by making it affirmative there will be four real roots: That the first part of the expression must be greater than the second will be evident from observing, that if $A = o$, then all the roots will be impossible.

2. If both n and m be odd numbers, and $\frac{\overline{m-n}|^{\,n-m}}{n^{n-m}} \times A^n - \frac{n^n}{m^m} \times B^{n-m}$ affirmative, then there will be three possible roots; otherwise only one. Because n is an odd number there must be one real root: and if the above expression $= o$, there will be other two roots equal. But if A and B be taken such as to make it affirmative, there will be other two real roots. For $n-m$ is an even number, therefore the first part of the expression is positive; and if $A = o$, there will be only one real root, and the above expression would in that case be negative. Therefore, &c.

If n be odd, and m even, and A, and B, have the same sign, then the equation will have only one real root; this requires no proof. But if they have different signs, and at the same time $\frac{\overline{m-n}|^{\,n-m}}{n^{n-m}} \times A^n - \frac{n^m}{m^m} \times B^{n-m}$ have a contrary sign to B, then the equation will have three real roots; otherwise but one.—If the equation have this form, viz. $x^n + A x^m - B = o$, then $\frac{\overline{m-n}|^{\,n-m}}{n^{n-m}} \times A^n$ will be positive, and it must be greater than $\frac{n^m}{m^m} \times B^{n-m}$, for reasons given above; therefore the whole is positive. But if it be of this form, viz. $x^n - A x^m + B = o$, then the first part of the general expression is negative, and the second part positive, wherefore the result must be negative.

Conjectures *on the* Use *of the* ancient Terrassed Works, *in the* North *of* England. *By* John Ferriar, M. D.

IN the northern counties of this kingdom, the ſides of hills are in many places divided by regular terraces, evidently artificial. Such works are firſt obſervable in Weſtmoreland and Cumberland; in Northumberland they are very numerous. It is uncertain whether they exiſt in Scotland, for the ſilence of Antiquarians, who are generally bad judges of earthen works, affords no proof to the contrary. Probably, the famous parallel roads of Glenco, deſcribed in the Appendix to Mr. Pennant's Tour, are terraces of this kind, as they abound in the avenues of hilly and difficult countries. The extent of theſe works is very different; in ſome places, there are not more than three or four rows of terraces, capable altogether of containing an hundred men; but in others, the terraces mount almoſt to the ſummits of lofty hills, and would lodge a conſiderable body of troops. At the battle of Humbledon, the Scottiſh army is ſaid to have been poſted on one of theſe works,

works, which is the moft extenfive I remember to have obferved.

That fuch terraces were intended for military purpofes, can hardly be doubted ; but in what age, or with what particular view they were formed, has never yet been determined.

Mr. Wallis, in his Antiquities of Northumberland, fuppofes them to have been ftations for parading the militia; but it is improbable, that in rude times, fo much exertion fhould have been employed, in places not eafily acceffible, for a purpofe, to which a level furface was much better adapted. On the contrary, their pofition, on commanding fituations, fecured by precipices, or difficult eminences on both flanks, or covered by advanced works of the fame kind, but of fmaller fize, points them out as lines of defence. I believe they are chiefly to be traced on the moft acceffible parts of a high country, or rifing from the brink of a river, to defend the paffage. By what people they were raifed, it is very difficult to conjecture. They differ in every particular from the Britifh works, defcribed by Cæfar, and are probably of more recent date, for they indicate the accefs of the invaders to the interior, and ftronger part of the country. And no traces of the Britifh dry walls appear in them, although ftone is plentiful on the very ground where they are formed. They refemble,

ble, in fome places, the Danifh field-works, but their great extent, and pofition with refpect to the fea and low country, for they chiefly point to the Eaft and South, render it improbable that they are of Danifh origin. I was once inclined to think, that they were conftructed to oppofe the progrefs of that people, becaufe confiderable terraces are vifible, on the floping eminences of fome fields, near Bambrough Caftle, in Northumberland, which, among a great variety of entrenchments, contain fome beautiful femi-circular Redoubts, with triple ramparts.* But in a fhort ramble to the Lakes, in Spring, 1791, the view of ORTON SCARR, between KENDAL and APPLEBY, and of the neighbouring country, induced me to believe, that if this kind of defence were employed againft the Danes, it had been, however, of earlier origin.

ORTON

* Thefe fields deferve particular inveftigation. They are fituated near the village of North Charleton, but diftinguifhed neither by hiftory nor tradition. They contain works of very different magnitude and conftruction, which in the whole, appear to be capable of lodging 40,000 men. In conjunction with a feries of pofts on the neighbouring eminences, they indicate a powerful invafion, and perhaps a fucceffion of engagements in the plain. Whoever would examine them, (and they would amply repay attention) fhould begin with the circular Camp on the perpendicular rock of Spindlefton, behind which the invaders feem to have landed, and proceed along the chain of rifing grounds to the fields.

Orton Scarr, (or Rock) of which I have given a very imperfect ſketch from memory, lies on the north-eaſt, directly oppoſite the lower opening of the paſs of Brederdale, at the extremity of a narrow valley, watered by a ſmall river. The front of the precipice is occupied by three rows of terraces, reſembling two round baſtions, connected by a curtin. On the more level part of the hill, under the beacon, ſome lines appear to have been drawn, but I had not leiſure to trace them. Near the road, ſomewhat in the rear of the terraces, two ſmall cairns are viſible. The paſs of Brederdale, which the traveller deſcends, in going northwards, is a ſteep and winding defile, commanded by precipitous hills. Where it begins to ſpread out towards the valley, we meet with a conſiderable Roman ſtation, occupying nearly the whole breadth of the paſs, from the ſteep bank of the rivulet, to the foot of the declivity. It appears to have been fortified with care, for it is ſurrounded by a lofty double rampart, and two ditches. In the bottom, where the banks of the rivulet are level, appear the traces of Castle How, which I ſuſpect to be founded on the ſite of a Roman caſtellum, deſigned to protect the watering parties. It is in full view of the ſtation. Thus we are preſented with the appearance of two

hoftile garrifons, evidently invading and invaded. At prefent, all is folitarinefs and filence:

> Stat circum alta quies, curvoque innixus aratro
> Defertas foffas, et caftra minantia caftris
> Rufticus invertit, tacita formidine luftrans
> Horrorémque loci, et funeftos ftragibus agros.
>
> Addifon. Pax Gulielm.

On the oppofite bank of the rivulet, lower than Castle How, appears to have been another Caftellum. At the entrance of the defile, from the fouth, a few flight traces of terraces are feen, and the remains of a fquare entrenchment, with a fhallow ditch, are difcovered, adjoining, in the flat country. In temporary encampments, the Romans commonly ufed a ditch, from three, to five feet deep. Thefe filent monuments imprefs a connected ftory, on the mind of the Obferver, and perhaps afford fome materials, for recovering a loft Chapter in History. Happily, the antiquarian vifion I am about to recite, obliges us to erafe nothing already recorded.

It feems, from the imperfect account of Tacitus, that Agricola was the firft Roman Commander, who penetrated into that part of the country, in which thefe Antiquities are fituated. Cerealis had reduced the Brigantes of Yorkfhire, but the inhabitants of Chefhire, and Lancafhire

were

were unſubdued, and the people of Weſtmoreland had probably ſecured themſelves, in their rocks and defiles. The incidents of Agricola's firſt campaign are only hinted at by Tacitus, and moſt of our Antiquarians have contented themſelves with ſuppoſing, that he entered Yorkſhire by the way of ISURIUM, or ALDBOROUGH. But the firſt operation of that General was to recover the Iſle of MONA, or ANGLESEY, immediately before his troops went into winter quarters, and it is probable from the expreſſions of Tacitus, that in the following ſpring he proceeded northwards, along the coaſts of Cheſhire and Lancaſhire: "loca caſtris ipſe capere, "*æſtuaria* ac ſylvas ipſe prætentare ---- nulla "ante Britanniæ nova pars illaceſſita tranſierit." The word ÆSTUARIA, can only refer to the inlets of the Weſtern coaſt: the æſtuaries of the MERSEY and RIBBLE, and the BAY of MORECAMB, the *Moricambe Æſtuarium* of the Romans. Mr. Whitaker, in his learned hiſtory of Mancheſter, has therefore conjectured, with great probability, that in 79, after overcoming the Cornavii, Agricola invaded Lancaſhire. The appearances I have deſcribed, induce me to add to his conjecture, that the campaign was probably cloſed by an invaſion of Weſtmoreland and Cumberland, and that in its courſe, Orton Scarr was attacked and taken. The ſtrong country, with which the

 paſs

pafs of Brederdale communicates, might have been the refuge of part of the Brigantes, who had efcaped from the attack made by Cerealis on the low country. From the number of Britifh and Roman remains in this neighbourhood, it plainly appears that the hilly country was formerly well peopled, and confidered as an important diftrict. No part of it was neglected. Even the dreary pafs of Borrodale received a Roman garrifon. And while the religious horror of the adjoining mountains, favoured the myfterious impoftures of the Druids, the beauty and convenience, of the vales and lakes, muft have early attracted numerous inhabitants—The changes in the feat of population, in this ifland, have been fo great, that in judging of the importance or remotenefs of any Northern part of the country, in former times, we may almoft venture to reverfe its prefent condition. To this retreat, fome of the Britons might bring an imperfect knowledge of the Roman art of war, and the invention of terraffed ramparts might then be fubftituted for the walls of loofe ftones, which the firft defenders of this country oppofed to the efforts of the legions. Whether Agricola, after fubduing the Siftuntii of Lancafhire, failed up the Bay of Morecamb, or whether he proceeded along the coaft, fixing a ftation at Lancafter, I fhall

ſhall not undertake to enquire. It is certain, that in the route from the Bay of Morecamb to Kendal, various traces of ancient entrenchments are viſible; but Dr. Stukely, by a ſtroke of his lively pen, has turned thoſe ſcarce diſcernible mounds into ſplendid cities. Apart from this fancy of multiplying Palmyras in the deſart, Dr. Stukeley was a moſt acdute antiquarian, and an excellent judge of field-works in particular. It is therefore dangerous to queſtion his authority, on this point.

Suppoſing, then, Agricola to have advanced, in his firſt campaign, by the paſs of Brederdale, let us try how far the ſeries of field-works deſcribed, will aſſiſt us in recovering a fragment of his hiſtory. The ſlight terrace-work, at the entrance of the defile from Kendal, ſhews that ſome attempt was made to reſiſt the invading army there. The Romans had therefore encamped, as the ſquare entrenchment indicates, hard by the paſs, till the enemy retreated, or was diſlodged. When the invaders reached the bottom of the defile, their camp would probably be ſtrongly entrenched, as the poſt of Orton Scarr, commanding all the interjacent country, would then appear very formidable. Whether the Caſtella were then thrown up, to protect the watering and reconnoitring parties, or whether theſe were ſubſequent works, for the ſecurity of the ſtation, it is impoſſible to determine.

The

The former conjecture is not improbable. To paſs the valley, then perhaps marſhy, or covered with thickets, under the eye of a vigilant enemy, expecting an attack, was an operation that might require a delay of ſome days, and after all, it was impoſſible to attack the poſt in front. The lines therefore muſt have been turned, at the acceſſible part of the hill, near the ſituation of the preſent high road, and perhaps the cairns point out the very place of the aſſault. The ſucceſs of this action, would open the way to Carliſle, and to the ſea. Other terraces appear on a riſing ground near Penrith, facing towards Keſwick, the road from which paſſes through them. And on the ſide of a hill, fronting the river Eimont, near Brougham Caſtle, a conſiderable terraſſed work is very diſtinguiſhable. But no probable conjecture can be formed, reſpecting the other incidents of this campaign. Perhaps I have ventured ſufficiently far already.

No remains of parapets are ſeen on any of theſe works, which have come under my obſervation, although the ramparts ſeem to retain their original height. If parapets were ever added to them, they would be liable to ſudden decay, by the action of winds and rains, in ſituations ſo greatly expoſed. At Orton Scarr, from the breadth of the platform of each rampart, it might be ſuppoſed that room was given for

Pl. V.

J. Ferriar M.D. del. P. M. Morland sculp.

ORTON SCAR.

for tents, or huts. But at Humbledon, and in other places, the breadth is only ſufficient for a ſingle file of ſoldiers. If this conſtruction was an attempt to imitate the Roman method of fortification, the ramparts might, like thoſe of the Romans, have been defended by projecting wooden towers, or paliſſades.

MISCELLANEOUS OBSERVATIONS *on* CANINE *and* SPONTANEOUS HYDROPHOBIA: *to which is prefixed, the* HISTORY *of a* CASE *of* HYDROPHOBIA, *occurring twelve Years after the* BITE *of a ſuppoſed* MAD DOG. *By* SAMUEL ARGENT BARDSLEY, M. D. M. R. M. S. EDIN. *and* C. M. S. LOND.

READ, OCTOBER 15, 1794.

TO add another inſtance of the want of ſucceſs in the treatment of Hydrophobia, to the melancholy hiſtories already publiſhed, may appear ſuperfluous and uninſtructive. Yet, when we conſider the peculiar fatality of this diſeaſe—the obſcurity of its proximate, and, even, ſometimes of its occaſional cauſe—and, how few opportunities are afforded of minutely attending to its preceding and attendant phænomena,

mena, there may be ſome reaſon to imagine, that every faithful deſcription of facts will be productive of advantage; and may probably at length lead to the eſtabliſhment of a juſt theory, and a ſucceſsful mode of cure. The following caſe has a peculiar claim to attention, on account of the great diſtance of time, from the bite of a ſuppoſed rabid animal, to the appearance of the diſeaſe. It is, indeed, a difficult taſk, to aſcertain a fact of this nature; and eſpecially, when enquiries are to be made from ignorant and prejudiced perſons. As it is, however, a matter of the utmoſt importance to be eſtabliſhed, no pains have been ſpared, to gain every intelligence, which the Patient and his friends were capable of communicating. The reſult of the enquiry is in favour of the Patient's repeated aſſertion: "That he had "never ſuffered the leaſt injury, from any ani-"mal; except the bite, inflicted twelve years "ſince, by an apparent mad-dog."*

John

* The Patient had lived at the village of Aſhworth, near Bury, from the period of the bite, till within two months of his death, when he removed to Fearn Gore, in the ſame neighbourhood. An enquiry was made in every family, at both places, relative to there having been any mad animal in their neighbourhood, during Lindſay's reſidence among them; and, if ſo, whether they had ever heard,

John Lindſay, weaver at Fearn Gore near Bury, in the county of Lancaſter, aged thirty-ſix, of middling ſtature, and ſpare habit of body, and of a temperament inclined to the melancholic, was brought into the Mancheſter Lunatic Hoſpital, on Friday May the ſixteenth, 1794, about three o'clock in the afternoon. He was immediately viſited by Dr. Le Saſſier, who obligingly communicated to me the following particulars. The Patient expreſſed feelingly his ſenſe of danger, from the perſuaſion that his diſorder proceeded from the bite of a mad dog. He was deſired to drink a little cold water, which on being preſented to him he rejected, with every appearance of diſguſt and horror. Being again ſtrongly urged to drink, he made the attempt, and with great exertion got down a ſmall quantity of the liquid. He was perfectly rational, but appeared apprehenſive of danger from the leaſt noiſe, or approach of any perſon towards him. He expreſſed a deſire to make

heard, or ſuſpected, that he had been bitten, or otherwiſe expoſed to the danger of infection. They all agreed in returning a negative anſwer to both theſe queſtions. I ought further to obſerve, that as both theſe villages contain few families, and theſe, without one exception, having dwelt in the ſame place, from the time of the Patient's coming among them, to the attack of his complaint, their evidence in ſupport of the Patient's declaration, is complete and ſatisfactory.

water, and was quitting the room for that purpoſe ; but no ſooner had he approached the door than he ſuddenly retreated, complaining of an unpleaſant ſenſation he felt from the cold air, and particularly that it produced a convulſive twitching, about his throat. To ſcreen him from the effects of the air, when conveyed from the examining room into the Hoſpital, an umbrella was held over his head, and his body cloſely muffled up in a wrapping cloak. As ſoon as he had got into his apartment, he ate ſome bread and cheeſe, but with difficulty; and requeſted to be allowed to drink ſome buttermilk. He attempted to ſwallow this liquid, and in part ſucceeded ; but not without the moſt violent ſtruggling efforts, attended with diſtortions of his countenance, which remained ſlightly convulſed for ſome time afterwards.

A conſultation of the Phyſicians of the Hoſpital being called by Dr. Le Saſſier, and the aſſiſtance of Dr. Percival, Phyſician extraordinary to the charity, requeſted; the latter Gentleman, in concurrence with Dr. Le Saſſier, (the reſt of the Faculty being out of the way) entertained not the leaſt doubt of this Patient being afflicted with genuine Hydrophobia. As the diſorder was far advanced, and might, indeed, be conſidered as nearly terminating, being the third day from the appearance of the ſymptom

tom of Hydrophobia, little or no advantage could be expected from medicine. He was ordered, however, about four o'clock the ſame afternoon, to take a bolus compoſed of twelve grains of muſk, two grains of opium, and ſix grains of camphor. Two drachms of ſtrong mercurial ointment were alſo directed to be rubbed in upon the throat and breaſt. I ſaw the Patient, in company with the other Phyſicians, about ſix o'clock the ſame evening; and we found him very willing, and ſufficiently compoſed, to give a diſtinct account of the circumſtances preceding the diſeaſe, and to deſcribe his ſufferings ſince its attack. The following particulars were collected. He has been induſtrious, ſober, and regular in his mode of living; but ſubject to low ſpirits from the difficulty he found, at times, of maintaining a wife and ſix young children. His exertions, however, were in general proportionate to his difficulties. But of late, from the depreciation of labour, he found, that the moſt rigid œconomy and indefatigable induſtry were not ſufficient to ward off, from himſelf and family, the calamities of hunger, debt, and the moſt abject poverty. The anxiety of his mind now became almoſt inſupportable. As the laſt refuge for his diſtreſs, he applied, a few days previous to the attack of his complaint, to the Overſeers of his Pariſh for their aſſiſtance to pay his rent, and thereby pre-

vent the ſeizure of his goods; but obtained no relief. Overwhelmed with grief and diſappointment, he yielded to deſpair, reſigning himſelf and family to their wretched fate. He was ſoon rouſed from this ſtate of fancied apathy, by the piercing cries of his children demanding bread. In a paroxyſm of rage and tenderneſs, he ſat down to his loom on the Monday morning, and worked night and day, ſeldom quitting his ſeat, till early on the enſuing Wedneſday morning. During this period of bodily fatigue and mental anxiety, he was entirely ſupported by haſty draughts of cold buttermilk, ſparingly taken. Nor did he quit the loom, until his ſtrength was completely exhauſted. He then threw himſelf upon his bed, and ſlept a few hours. On waking, he complained of giddineſs and confuſion in his head, and a general ſenſe of wearineſs over his body. He walked five miles that morning, in order to receive his wages, for the completion of his work; and, on his return, felt much fatigued, and troubled with a pain in his head. During the night, his ſleep was interrupted by involuntary and deep ſighs—ſlight twitchings in the arms—and a ſenſe of weight and conſtriction at the breaſt. He complained of much uneaſineſs at the light of a candle, that was burning in the room. On evacuating his urine, he was obliged

obliged to turn afide his head from the veffel, as he could not bear the fight of the fluid without great uneafinefs. Being rather thirfty, he wifhed for balm tea to drink; but was unable to fwallow it from a fenfe of pain and tightnefs, which he experienced about the throat, when the liquid was prefented to him. He fuddenly exclaimed, on perceiving this laft fymptom, "Good God! It is all over with me!" and immediately recalled to his Wife's recollection, the circumftance of his having been bitten,* twelve years ago, by a large dog apparently mad; which was flying from the purfuit of a number of people, on the high road between Warrington and Manchefter.

During the whole of Thurfday, his abhorrence of fluids increafed; and he now began to feel an uneafy fenfation on being expofed to the air. The flight twitchings of his arms were alfo increafed to fudden ftartings; attended with a violent agitation of his whole body. He had fuffered

* Soon after this accident, he applied to a Surgeon at Afhton in this neighbourhood, who dreffed the wound for a fhort time, and ordered the Ormfkirk medicine to be taken. The wound was fpeedily healed; and the Patient had never diftrufted his being cured, till the moment he was unable to fwallow liquids. I wrote to the Surgeon, with a view of obtaining particular information relative to the ftate of the wound, &c.; but, the circumftance had altogether efcaped his memory.

ſuffered much from his journey, being brought eight miles in an open cart. I perceived at this time (half paſt ſix, Friday evening) that his countenance expreſſed the utmoſt anxiety; his breathing was laborious and interrupted; and he complained of a dull pain, ſhooting from the arms towards the præcordia and region of the ſtomach. A livid paleneſs overſpread his face; the features were much contracted; and the temples moiſtened with a clammy ſweat. He ſuffered greatly from exceſſive thirſt, and dryneſs of the mouth and fauces.*

An unuſual flow of viſcid ſaliva occaſioned him to ſpit out frequently. He complained of a remarkably fetid taſte in his mouth, and a loathſome ſmell in his noſtrils. He ate ſome bread and butter, at his own requeſt, but with great difficulty, as he was obliged to throw his head backward, in order to favour the deſcent of the morſel down the gullet. He was requeſted to waſh down this ſolid food, with ſome liquid; and he expreſſed a readineſs to make the trial. On receiving a baſon of buttermilk, he

* We now examined the part that had been bitten, and diſcovered a ſlight *cicatrix*, almoſt obliterated, upon the origin of the *Tendo Achillis* of the left leg. He had never ſuffered any pain, nor complained of the ſlighteſt uneaſineſs, in that or the neighbouring parts, ſince the wound healed. No alteration in the colour of the ſkin was perceptible.

he haſtily applied it, with a determined countenance, to his lips; when he was inſtantly ſeized with ſo ſevere a ſpaſm and rigidity of the muſcles of the neck, that he was compelled, in an agony, to deſiſt from drinking. Shortly after, he raiſed himſelf upon his knees in bed, took the bowl again into his hands, and by forcibly ſtretching his neck forward, at the moment he received the liquid into his mouth, and then violently throwing his head backwards, he ſucceeded in ſwallowing a ſmall portion. He appeared highly gratified with the ſucceſs of this effort, and the fortitude he had exhibited; and exultingly demanded another draught of the butter-milk, as he now thought he could conquer the difficulty he had hitherto experienced. But a violent return of the ſpaſms in the throat and neck checked this attempt. Theſe convulſions were terminated by the ſtomach diſcharging the liquid previouſly ſwallowed, highly tinged with bile. I perceived that he had conveyed a piece of orange, under the bed cloaths, which at intervals he applied to his mouth by ſtealth, and as it were unperceived by himſelf; for he conſtantly hurried it to his lips, when his attention appeared to be engaged on other objects. This ſtratagem did not ſucceed. No ſooner had the morſel touched his mouth, than he was ſeized with convulſions

about

about the throat, and a ſtricture at the breaſt. I ſaw him again, in conſultation, at eight o'clock this evening. He had taken two doſes of the bolus; and the ointment had been carefully rubbed in. He appeared rather more compoſed, but expreſſed great anxiety at the idea of being left alone. He courted eagerly the converſation of thoſe around him; apparently from the motive of withdrawing his mind from the contemplation of his miſerable ſtate. The repugnance he felt at ſwallowing liquids, and the uneaſineſs occaſioned by the attempt, he now conſidered as his chief complaints; and was determined to conquer the firſt by perſeverance, and an undaunted reſolution. His ſpaſms ſeemed to be ſomewhat mitigated, as he got down a little milk-porridge with leſs difficulty than uſual. A repetition of his medicines every three hours, was ordered during the night. At nine o'clock the next morning (Saturday) he was viſited again; and we learned that he had paſſed the night without a moment's reſt, frequently ſhouting out with looks of horror, and ſometimes wailing in broken and confuſed murmurs; but, on being ſpoken to, he always returned rational anſwers. He was now alarmed to a degree of diſtraction, at being left alone. He examined every object with a timid and ſuſpicious eye; and, upon the leaſt noiſe of a

footſtep

footſtep in the gallery, he begged, in the moſt piteous accents, to be protected from harm. He had never offered the leaſt violence to any one, ſince the commencement of the diſeaſe; and, even now, when the encreaſed ſecretion of ſaliva occaſioned him to ſpit out very frequently, he apologized to the by-ſtanders, and always deſired them to move out of the way. I obſerved, he frequently fixed his eyes, with horror and affright, on ſome ideal object; and then, with a ſudden and violent motion, buried his head underneath the bed-cloaths. The laſt time I ſaw him repeat this action, I was induced to enquire into the cauſe of his terror.—He eagerly aſked, if I had not heard howlings and ſcratchings? On being anſwered in the negative, he ſuddenly threw himſelf upon his knees, extending his arms in a defenſive poſture, and forcibly throwing back his head and body. The muſcles of the face were agitated by various ſpaſmodic contortions;—his eye balls glared, and ſeemed ready to ſtart from their ſockets;—and at that moment, when crying out in an agonizing tone:—"Do you not ſee that black dog?" his countenance and attitude exhibited the moſt dreadful picture of complicated horror, diſtreſs and rage, that words can deſcribe, or imagination paint!—The irritability of the whole ſyſtem was now become exceſſive. He

 diſcovered

diſcovered the higheſt degree of impatience on the leaſt motion of the air. Every action was accompanied with that hurry and inquietude, which marks an apprehenſion of danger from ſurrounding objects. The oppreſſion of the præcordia was evidently encreaſed; and, when he gaſped for breath, the whole body was writhed with convulſions. His ſpeech was interrupted by convulſive ſobs. The pulſe was tremulous and intermitting; and, at ſome times, ſo hurried as not to be counted. He had frequent retchings, and brought up occaſionally ſmall quantities of a yellow liquid. Solids were now ſwallowed with exceſſive difficulty; and the attempt always produced ſtrong ſpaſms about the neck and breaſt. At ten o'clock (the ſame morning) we met in conſultation; when the medicines were ordered to be repeated every two hours, with an increaſe of the doſe of opium, from two to three grains. Half an ounce of ſtrong mercurial ointment was ordered to be rubbed in, over the ſurface of the body, and a ſponge dipped in vinegar to be conſtantly held to the mouth and noſtrils. At four o'clock the ſame day, the conſultation was renewed. We found the patient had been able to ſwallow his boluſes without much difficulty, and had drank ſeveral times with infinitely more eaſe than uſual; but, the fluid had been immediately rejected by the ſtomach, and had come

up,

up, deeply tinged with yellow. His countenance exhibited a cadaverous aſpect. His voice was hoarſe, indiſtinct, and faltering. He complained of a fixed pain at the region of the ſtomach; which he had felt, more or leſs, during the diſeaſe. The pulſe was feeble, and ſcarcely perceptible. He ſwallowed ſome tea with leſs difficulty, than had been obſerved ſince his entrance into the hoſpital. His diſſolution was apparently drawing near: yet, it was deemed adviſable to order his body to be rubbed with warm oil; and one ounce of that fluid to be taken every half hour, or as often as the ſtomach would bear it. His mental faculties at this period ſuffered very little derangement; for although, when not attending to external objects, he would utter ſome incoherent ſentences; yet, the moment he was ſpoken to, he was perfectly collected, and returned rational anſwers. At half paſt four o'clock, he ſubmitted willingly to have his body rubbed with the oil, and for that purpoſe ſat down upon the ſide of the bed; when he was ſeized with an inſtantaneous convulſion, threw himſelf backward—and expired without a groan! An immediate inſpection of the body would have been a deſirable circumſtance: but, we were obliged, (however reluctantly) from unavoidable impediments, to defer the diſſection

 till

till the following morning. Accordingly, on Sunday morning, about ten o'clock, the body was opened in the presence of one of the physicians, myself, and two of the Surgeons belonging to the charity. I have to regret that the examination did not extend to the brain; and indeed, that a more minute investigation of the morbid appearances, accompanying this fatal malady, did not take place. But, such was the peculiar horror inspired by a view of the progress and catastrophe of the disease, that the accustomary dread of danger arising from any examination of an hydrophobic subject, was increased in this instance, to a tenfold degree. Besides, the well known prejudices entertained by the country people, against the opening of dead bodies, rendered us anxious to finish the inspection before the arrival of the patient's friends, who were hourly expected. In the cavity of the thorax no unusual appearances were discovered; except, that the surface of the lungs appeared of a darker hue, and more distended with blood than usual. No inflammation appeared on an inspection of the fauces; nor were the muscles of the Larynx or Pharynx in the least discoloured. The stomach and Œsophagus were removed from the body, and subjected to particular inspection. A longitudinal incision was made through the whole

cavity

cavity of the Œſophagus, but not the leaſt marks of diſeaſe were diſcovered. Upon opening the ſtomach, evident traces of inflammation were obſerved. It commenced at the ſuperior orifice, and was there confined to ſmall and irregular ſpots of a dark red colour; and might alſo be traced in a linear form, and of a brighter red, along the curvature of the ſtomach, terminating at the pylorus in large and irregular ſpots of a gangrenous appearance. The contents of the ſtomach did not exceed three ounces; and conſiſted, chiefly, of the medicines that had been ſwallowed, mixed with a dark coloured fluid. All the other viſcera of the abdomen exhibited no marks of diſeaſe.

The novelty and importance of the caſe above related, will, I truſt, ſufficiently apologize for the following enquiry. That it exhibits the genuine ſymptoms of Rabies Canina, will not be doubted by thoſe, who have had opportunities of ſeeing the malady, or have conſulted the beſt authorities on the ſubject. The dread of liquids; the peculiar and diſtreſſing anxiety about the præcordia; and the morbid irritability of the nervous ſyſtem, which were all experienced by this patient, leave no room for doubt concerning the reſemblance of the diſeaſe to that which is the offspring of the canine poiſon. When we reflect on the length of the interval, from

from the infliction of the bite of a ſuppoſed rabid animal to the appearance of this diſeaſe, an important queſtion naturally ariſes:—Are we to conſider this caſe as ariſing from the influence of the canine poiſon; or as an inſtance of what authors have termed ſpontaneous Hydrophobia? A variety of caſes, related by different writers, ſeem to prove the exiſtence of Hydrophobia, unconnected with the bite, or agency of the poiſon, of any rabid animal. The generality of ſyſtematic authors mention the occurrence of canine madneſs at the diſtance of many years from the application of the poiſon of a diſtempered animal. It has, alſo, been aſſerted, that the contact of the ſaliva of a mad animal with the body is capable of producing Hydrophobia. Indeed, ſome authors have gone ſo far as to maintain, that the volatile parts of the ſaliva, being carried off with the breath of a rabid animal, have been capable of producing the diſeaſe, when received into the ſtomach or lungs of any perſon.

I am fully ſenſible of the caution to be obſerved, in drawing poſitive inferences from the generality of medical hiſtories on this ſubject:—For an attachment to the marvellous; a blind obedience to authority; and a rage for hypotheſis ſeem to have poſſeſſed the ancient ſyſtematic writers, who have treated on this malady. In order,

order, therefore, to appretiate the credit due to thefe various hiftories, and to the opinions derived from them, I fhall only cite the moft refpectable authorities; and, indeed, chiefly confine my attention to thofe cafes, which have been fubjected to the infpection of their refpective relaters. I proceed, therefore, to confider, firft, the hiftories and facts that have been adduced in favour of the opinion, that the canine poifon has lain dormant for a great length of time, and afterwards been excited into action: Secondly, thofe cafes, which have been attributed to the contact of the faliva of a rabid animal with the furface of the fkin; or to its application, internally as well as externally, by any other mode than the intervention of a bite: Thirdly, fuch inftances of the difeafe, as have been faid to have arifen fpontaneoufly, * or, at leaft, whofe origin

* I have adopted the term "Spontaneous Hydrophobia," in conformity with the ufage of the generality of medical writers. But I wifh it to be underftood in a fenfe different from that, in which it is commonly ufed. For, notwithftanding all the ufual fymptoms of canine madnefs have arifen in many cafes, without the intervention of the poifon of a rabid animal, I do not conceive, in fuch inftances, any fpecific poifon to have been generated in the habit—The canine virus operates, not only as a ftimulus on the nerves, but alfo appears to produce a fpecific action

origin could not be traced to a bite, or any other mode of infection, from a rabid animal.

I. It

action in the salivary glands, and thereby effects a change in their secretions: at least, this change takes place in the canine race.—But, there is no proof of such an assimilation of the saliva occurring in any instance of hydrophobia, arising spontaneously, or excited by any other cause than that of the poison of a mad animal. Therefore, as we know that a variety of stimulant powers are capable of producing effects analogous to those excited by the canine virus, it is more consistent with the rules of just induction, to attribute the symptoms of spontaneous hydrophobia to the operation of these powers, than to have recourse to the vague conjectural idea of their being produced by a specific poison, generated in the body. Nosologists have considered spontaneous hydrophobia, as a *species* of the *Genus* HYDROPHOBIA; but their definitions are inaccurate—It is the HYDROPHOBIA *simplex* of Dr. Cullen, and is defined: HYDROPHOBIA *(simplex)* sine rabie vel mordendi cupiditate," in contradistinction to the first species, which he describes to be: "HYDROPHOBIA *(rabiosa)* cum mordendi cupiditate, ex morsu animalis rabidi." The second species of Cullen corresponds with the HYDROPHOBIA *spontanea* of Sauvages, as his first agrees with the HYDROPHOBIA *vulgaris* of the same author. These definitions do not rest upon facts. For, so far is the "cupiditas mordendi" from being an essential symptom in the HYDROPHOBIA *rabiosa*, that it very rarely occurs in that disease—On the contrary, this symptom has taken place in several cases of the HYDROPHOBIA *simplex* or spontaneous Hydrophobia, related in the course of this enquiry; but, it by no means seems to be an essential symptom of the disease, in either species.

I. It is difficult to afcertain any precife period for the appearance of this difeafe, after the communication of the poifon. From forty days to three months, may, perhaps, be confidered, taking modern writers for our guides, as the average diftance of time—But the interval of the appearance of the difeafe from its fuppofed caufe, according to fome writers, is fo indeterminate, as to include a period of time, from one day, * to forty years. † There are, however, feveral well authenticated cafes, in which the difeafe occurred at the diftance of fix months, one year, and even a longer period, from the communication of the virus. In the *Act. Norimberg.* ‡ a well marked cafe of canine madnefs is defcribed of a gardener, who was bitten September the 25th. 1720, and died, hydrophobic, on the 8th. of May, 1721.—Another indifputable cafe is recorded, in the fame work, of a patient who fell a victim to the malady nearly a year from the date of the infection. In the *Ephemerides N. C.* § the hiftory of a young woman, bitten by a rabid animal, is detailed; in which it appears, that the poifon

 lurked

* Medical Comment. vol. V. p. 304.

† Morgagni, de Cauffis et Sed, Morbor, epift, viii. art 21.

‡ Obferv. 7. vol. i.

§ Ann, 7mo, obs. 148.

lurked dormant for the ſpace of one year, and then proved fatal.

Galen * aſſerts from his own knowledge, that the diſeaſe in one inſtance did not appear till after the ſpace of a year, from the communication of the poiſon. Actuarius † affords a ſimilar proof of the diſeaſe occuring ſix months, and, even, one year, from the date of the bite. Dioſcorides ‡ has obſerved, that although the diſeaſe, for the moſt part, diſcovers itſelf in forty days after the infection; yet, in ſome inſtances, ſix months and even a year have intervened. Though we may be fully warranted to conclude, from the teſtimony of the above authorities, to which many later examples might have been added, that the ſymptoms of canine madneſs have not been manifeſted till ſo long a period as twelve months after the infliction of the bite; yet we can place little dependance on the teſtimony of many authors, who have

* "Novi ſane & quendam, qui, exacto anno, in eum "incurſit affectum, quem Hydrophobiam vocant."

Galen. *lib. Prorrhet. ſect* 2. *com.* 17.

† "Attamen poſt ſex menſes, & anno elapſo, invadere "contigit, ut nos ex *experientiâ* comperimus."

Actuar. *Method. Medendi. Lib. viii.*

‡ "Cum enim ut plurimum ad quadrageſimum usque "diem differri conſueverit; neglectis tamen quibusdam, "poſt ſemeſtre, imo etiam poſt annum, ſuperveniſſe obſervabimus."

Dioscorid. Lib. vi. *Cap.* 3.

have endeavoured to prove the occurrence of this difeafe, at the diftance of five, feven, and, even twelve years, from the communication of the poifon. Salius,* who ranfacked all the writers of antiquity on this fubject, has brought forward a variety of inftances to prove the exiftence of thefe facts. But we fhall find, that Salius has been contented to rely on very flender evidence, for the proof of his affertions. For inftance: he quotes the authority of Diofcorides as certifying the appearance of canine madnefs, after an interval of feven years from the infection: yet, what does this teftimony of† Diofcorides amount to? To nothing decifive: for, it goes no farther than to obferve, that *fome writers* have related feven years to have elapfed from the communication of the poifon to the appearance of the difeafe. Schenkius, Zacutus, Guinerius, Platerus, &c. and, almoft all the fyftematic writers of the 16th. and 17th. centuries have imitated the conduct of Salius. The Arabians furnifhed them with fome authorities,

 which

* "Hinc aliqui ad dies plures, alii ad menfes, aliqui "anno exacto, rabie corripiuntur; in nonnullisque pro- "ditum memoriæ ab antiquis habemus—hunc morbum "ad quintum, feptimum, & duodecimum annum, dilatum "fuiffe." SALIUS *de affect. partic.* p. 360.

† "Sunt, qui *narrent*, nonnullos poft feptennium, eo "affectu, correptos fuiffe." *Lib.* vi. *Cap.* 8.

which may generally be traced to the Grecian writers; and theſe, for the moſt part, relied on hear-ſay teſtimony, or, the inaccurate hiſtories of ſuppoſed caſes of Rabies canina. Albertus Magnus * ſpeaks poſitively, indeed, of a caſe, that fell under his own obſervation, in which the diſeaſe appeared after an interval of ſeven years from the bite of a rabid dog. Guinerius † has, likewiſe, pledged the authority of a friend; whom he eſteemed worthy of credit, for the occurrence of rabies canina, eighteen years after the patient had been bitten by a mad dog. The diſeaſe proved fatal on the third day. Salmuth, ‡ after quoting from various writers ſeveral inſtances of Hydrophobia taking place at the period of eighteen or nineteen years after the bite, relates one caſe, from his own authority, in which the ſymptoms occurred ſeveral years after the patient had been bitten by her huſband, who died of Hydrophobia.—Among later writers on this ſubject, the ſame habit of indiſcriminate quotation and eaſy credulity may be

* "Vidi hominem morſum a cane rabido in brachio, & "anno ſeptimo póſt incepit inflari locus cicatricis, & "mortuus eſt infra duos dies."

Albert. Mag. *de Hiſtor. animal. Lib.* xvii.

† "Quod cuidam, poſt decimum octavum annum a "cane rabido morſo, metus aquæ acceſſerit."

Tract. de Venenis.

‡ Salmuth, *Cent.* 1. *obſ.* 96.

be obſerved. Even the accurate Morgagni, * when treating on this ſubject, does not form an exception to the charge. He has quoted an authority from the German Ephemerides, † to ſupport his aſſertion, that the canine poiſon has lain dormant for twenty years, and then proved fatal. On conſulting the original it appears, that Morgagni either never read the caſe, but took it upon looſe authority; or has drawn falſe concluſions from a ſtatement of the facts. For the writer of this caſe relates, that his patient had been ſeveral days afflicted with a malignant fever; and alſo complained of a pain in the fauces, which were inſpected by a ſurgeon, and found inflamed.‡ Surely this laſt ſymptom, added to the great debility the patient laboured under, ſufficiently accounts for the averſion to ſwallow liquids, and the conſequent diſguſt experienced at the bare mention of them; without recurring (with the Phyſician) to the idle ſtory of the patient being bitten twenty years ago, by a dog ſuppoſed to be mad. In the other inſtance, of § forty years intervening

between

* *Epiſt. Anatom.* viii. *Art.* 21.

† *Ephem. N. C. Ann.* 9 & 10. *obſ.* 43.

‡ "Fauces erant ſicciſſimæ, & tandem ob defectum "humidi *inflammabantur*; malignitas indies creſcebat; "deliria accedebant, & octavo morbi die animam efflavit."

§. *Loc. prox. cit.*

between the bite and the difeafe, the authority which Morgagni has borrowed is extremely fufpicious and unfatisfactory. Gafpar a Reies, * to whom he has referred, after collecting at random a number of marvellous cafes from different authors, clofes the lift with a cafe on the authority of Alzaharavius, in which the interval of forty years took place from the date of the infection to the appearance of the diforder. It would, therefore, appear from this enquiry into the facts brought in fupport of the inactivity of the canine virus for fo long a period, that thefe writers have either been miftaken in referring the origin of the difeafe to a fuppofed far diftant caufe, when the actual one had efcaped obfervation, or that they erred from too readily adopting vague and hearfay teftimony.

II. With refpect to the influence of the canine virus in producing hydrophobia, when applied merely to the furface of the body, I apprehend we muft receive the various authorities, in favour of the fact, with fome degree of caution. That the difeafe has occurred from the contact of the faliva of a rabid animal with the

* "Quod magis eft, Alzaharavius, propria experientia, "teftatur, venenum per quadraginta annos in corpore "delituiffe."

Elyfium Jucundar. Queftion. Q. 61. N. 11.

the ſkin, independently of any bite, or the infliction of an apparent injury, I would not venture to deny: but that no imperceptible raſure of the ſkin by the teeth of the animal, or expoſure of the true ſkin from a previous ſcratch—deſtruction of a pimple—or any accidental injury had not taken place, in moſt of theſe caſes, I am rather inclined to doubt. In the German Ephemerides,* an inſtance is related of Hydrophobia occuring from the mere contact of the ſaliva of a mad animal, without the infliction of a bite.† Johan. Mathæus de Gradibus has furniſhed us with an inſtance of this diſeaſe, ariſing from a perſon applying his hand to the mouth of a mad dog. In this caſe,‡ though no bite was inflicted, yet the diſeaſe manifeſted itſelf at ſome diſtance afterwards. Matthiolus adviſes us not to treat with neglect the inſtances that have been adduced by various authors, of the production of Rabies Canina, by the mere contact of the ſaliva with the

* Ann. 7. Ob. 121.

† "Non quidem commorſa, ſed tantum ſaliva ex ore "ſpumante hinc inde in corpore commaculata eſſet; "octavo die, vehementi rabie correpta eſt, & tertia die "placidè obiit."

‡ "Johan. Coqueranus infectus fuit rabie poſt multos "dies, *ex ſola impoſitione manûs in os canis rabidi;* etſi "eum canis non momorderit."

JOH. MATHOEI *Conſul.* No. 82.

the naked body. He strengthens this cautionary advice, by bringing forward his own * authority to prove the occurrence of the disease, from the mere aspersion of the saliva on the bodies of two of his patients. Fab. Hildanus, in a letter to his friend Doctor Abel Roscius of Lausanne, laments the incredulity of many persons, who had treated as fabulous the account he had given of a remarkable case of Hydrophobia, arising solely from a woman having applied her lips and tongue to that part of a garment which had been torn by a mad animal. In order, therefore, to banish the scruples of the most sceptical, he subjoins a † history of the case, and pledges his veracity for the truth of the relation. To render this narration the more probable, he adds two cases which fell under his inspection, the year following the above

* "Quippe quod duos ego viderim, qui *spumâ tantum*, nullo quidem ex morsu accepto vulnere, rabiem "contraxerunt." MATTHIOL. *Comment. lib.* 6.

† "Matronæ cuidam in via obviam canis rabiosus, "qui vestem ejus dentibus arripiens, huc et illuc trahebat; "donec tandem, veste laceratâ, *cute tamen mulieris illæsâ* "*et intacta*, canis aufugit: illa, vero, nescia canem rabiosum fuisse laceratam vestem, *filo dentibus abscisso*, resarcire cœpit.—Tribus mensibus pòst, visionibus horribilibus "et pavoribus agitari cœpit, et aquam et vinum odisse, "et, quod pejus est instar canis latrare, dentibus domesticos arripere. &c."

FAB. HILDAN. *cent* 1. *Obs.* 86.

above mentioned event. The firſt is particularly deſerving of attention, as it affords certain proof of the danger to be apprehended, if the ſlighteſt raſure of the ſkin be expoſed to the action of the canine virus. It is the caſe of a young man, who received a ſcratch from a rabid cat, and that of ſo ſlight a kind as ſcarcely to raſe the Epidermis. * This accident happened the ſummer preceding that in which the diſeaſe occurred.—He died on the third day of the attack, under all the genuine ſymptoms of hydrophobia. It is probable in the preſent inſtance, that the claw of the animal was the medium by which the ſaliva was communicated to the injured cuticle. If this were the fact, how inconceivably virulent muſt be the action of this poiſon, when ſo ſmall a portion as could be conveyed by ſuch an inſtrument as the claw of a cat, was capable of producing the malady!—The ſecond caſe referred to by Hildanus, aroſe from the ſlighteſt bite imaginable of a rabid animal. This accident proved fatal to the ſufferer. The well-known hiſtory which †Cælius Aurelianus relates (founded on report only) of a woman ſuffering the baneful effects of the canine poiſon, from merely applying her tongue and lips to the infected threads of a garment,

 which

* *Obſ.* 86.

† *De morb. acut.* lib. 3. cap. 9.

which had been torn by a mad dog, might justly have been considered unworthy of credit, had not the case of Hildanus, and a similar one mentioned by Doctor Hamilton,* served to corroborate the testimony of this author. Cardan has also recorded the circumstance of his being called in to assist at a consultation, in a case of Hydrophobia; and, on an enquiry being made into the cause of the malady, the by-standers confessed, that the patient had kissed a rabid dog, previous to its being hanged.† The patient died the following day, according to the prognostic of his Physicians. These instances are corroborated by the following case. It was communicated to me by Dr. Percival, and is supported by his own respectable authority. A man residing at Worral in Cheshire, during his being asleep and lying on the ground, was licked about the mouth by an infected dog; but suffered *no bite*, nor the *slightest apparent injury* of the skin. He was, however, seized about the usual period with symptoms of Hydrophobia; and died of the disease, notwithstanding the usual preventive means had been adopted previous

* Hamilton "*On Hydrophobia,*" p. 22.

† "Adstantes confessi osculasse rabidum canem antequam "emitteret suffocandum:—Mortuus autem est sequente die, "ut nos prædixeramus."

Cardan, *Contradict.* 9. *Tract.* 5. *lib.* 2.

vious to its attack. Aretæus* affirms, that the breath of a mad animal being taken into the lungs of any perfon by infpiration, will produce the difeafe. This may be confidered, however, as a bare affertion, unfupported by any demonftration. Palmerius† has related the hiftory of a whole family, who were infected from kiffing their father, in compliance with his requeft, when juft expiring of canine madnefs. §

III.

* "Quinetiam et a rabido cane, qui in faciem dum "fpiritus adducitur tantummodo infpiraverit, et nullo "pacto momorderit, in rabiem homo agitur."

De caufis et fignis Morbor. Lib. i.

† *De Morbis contagiofis.* p. 266.

§ I conceive this extraordinary hiftory (and one related by Salmuth) deferving of little credit. Palmerius and Salmuth are the only writers (that I am acquainted with) who have ftated, *from their own knowledge*, that a bite from any perfon afflicted with canine madnefs, has been capable of communicating that difeafe to any of the human fpecies: — An abundance of negative facts might be brought to contradict this ftatement. But, as no abfolute conclufion can be derived from them, I would fuggeft the following reafons for rejecting the teftimony of the above-mentioned writers. Firft — If the faliva of an infected human-being were capable of producing canine madnefs in another of the fame fpecies, furely many inftances of this kind muft have occurred to the numerous writers on this fubject; efpecially, when the chance of perfons being expofed to the danger of fuch an accident is fo great, that, from *two* cafes only, which I have feen, *four* people were fubjected

III. I come now to the conſideration of the inſtances of ſpontaneous Hydrophobia. Its occaſional cauſes are various; fright—ſudden and violent affections of the mind—wounds received from enraged animals—the drinking of cold water, when the body has been previouſly heated—exceſſive fatigue in hot weather—have all been aſſigned by different writers, as the occaſional cauſes of this complaint. Indeed, in ſome inſtances, it has been difficult, if not impoſſible, to trace its origin to any occaſional cauſe. The following caſes, carefully ſelected from a variety of more equivocal authority, will prove the efficiency of the above mentioned occaſional cauſes in producing this diſeaſe; and alſo demonſtrate, that it has ſometimes occurred where no occaſional cauſe has apparently preceded. The five caſes recorded by Marcellus Donatus, and conſidered, by Morgagni,* as affording

to the danger of receiving the infection: two of them, by kiſſing the patient, and the reſt, by having had the ſaliva in contact with freſh wounds in their hands. Yet they all eſcaped without uſing any preventive means. Secondly, Dr. Vaughan has failed in his experiment of returning the diſeaſe from the human ſpecies to the dog. He inoculated that animal with the ſaliva of a rabid perſon, but without producing any effect. Thirdly, Salmuth and Palmerius are both fond of the marvellous; and their writings ſeem better calculated to excite ſurprize, than to convey information.

* *Epiſtol. Anatom.* 8. *art.* 31, 32.

affording certain proof of the exiſtence of ſpontaneous Hydrophobia, are particularly intitled to attention. Unqueſtionably, Morgagni was little ſcrupulous in miſleading his readers, when he brought forward *all* theſe caſes, as *equally* demonſtrative of the exiſtence of this malady. If he had examined them with his uſual accuracy, he would have found no room to cenſure the ſcepticiſm of thoſe, who differed with him in conſidering *them all* as undoubted inſtances of Spontaneous Hydrophobia. For, notwithſtanding we might give credit to the relation of Donatus, ſo far as reſpects the abſolute freedom from ſuſpicion, in all theſe caſes, of any infection having been communicated by a rabid animal; yet it does not follow that they ought to be conſidered as caſes of Hydrophobia, unleſs their ſymptoms warrant ſuch an inference. In the firſt caſe, * the complaint appears to have ariſen either from a laceration, or ſpaſm of the Œſophagus; or a Paralyſis of the muſcles of the Pharynx. The patient was ſeized ſuddenly at dinner, with a violent pain and conſtriction in and about the throat, which he attempted to remove by drinking ſome liquor, but found himſelf unable to ſwallow it. He remained incapable either of eating or drinking till the next day, when he ſwallowed ſome grapes, but would

* Marcell. Donat. *lib.* 6. p. 96 et 294.

would not be perſuaded to attempt to get down any liquid. He died the ſame evening.

2d. A woman was ſeized with a pain in her arm, attended with a violent tremor of the whole body. On the third day the pain ceaſed, but the trembling continued. She experienced a ſenſe of ſuffocation about the breaſt. If wine, water, or broth were preſented to her, ſhe fell into convulſions, and even faintings. She was able to ſwallow ſolids with perfect eaſe. The faculties of ſenſe and reaſon remained unimpaired.* Her diſpoſition was mild, and her converſation tranquil. She expired on the fifth day of the diſeaſe.

3d. A young woman was alarmed at ſeeing a combat with ſwords: ſhe had all the violent ſymptoms of Hyſteria, with the dread of liquids ſuperadded. Indeed, the ſhock appears to have been ſo violent, as greatly to injure the ſenſorium; for ſhe was highly delirious, intractable, and feveriſh. She died on the fifth day of the diſeaſe.

4th. A huſbandman, 27 years of age, after his uſual labour of the day, complained of a pain in his arm. On the eighth day of this complaint,

* "Si vinum, aqua aut juſculum propinetur, convellitur "et deficit: ova ac panem probe ſumat: facultates principes ac ſentientes valde conſtant," &c.

Marcel. Donat. *lib. vi.*

complaint, he was feized with flight fhiverings. He retired to reft on that evening, without having any inclination to eat. The family were alarmed in the night by his frequently uttering loud fhouts, and at times requefting he might be reftrained from injuring any one. His refpiration was laborious and interrupted. Donatus being called in to his affiftance, privately prognogfticated, that the patient would refufe to drink; and if he attempted it, would not fucceed; and alfo that his death was approaching. Thefe events fucceeded each other according to the prediction of the Phyfician; and the patient died in the fpace of four hours.

5th. A healthy and robuft countryman, was attacked fuddenly with fweatings and a conftriction, attended with anxiety about the precordia.* The inftant Marcellus Donatus faw the patient, he predicted, that he would neither fwallow liquids, nor live many hours. The prognoftic was fpeedily verified: for, when cold water was offered to the patient, he was feized with a fudden horror and fainting. The water being removed he prefently recovered.† He would by no means fuffer any one to

* "Cum anguftiâ cordis et agoniâ."

† "Namque ægrotanti oblatam frigidam aquam, ipfe "repentè horrefcit, et linquitur animo; eâ reductâ, actutùm revivifcit."

to approach him; nor could he bear, without great emotion, the ſweat to be rubbed from his face. If by accident the napkin fell upon his face, or preſſed lightly upon it, he ſeemed extremely afflicted and irritated. He expired in a few hours. Marcellus Donatus affirms, that in all theſe caſes the ſtricteſt enquiry was made, both from the ſufferers and their friends, relative to the patients having ever been expoſed to the influence of the canine poiſon; and that they aſſured him there was not the ſlighteſt ſuſpicion of a circumſtance of that kind ever having happened to any of them. Morgagni * cites the authority of Kochlerus for two caſes of Hydrophobia, in which the diſeaſe aroſe from the patients drinking cold water when violently heated. In the Journal de Medecine,† there are two inſtances recorded of Hydrophobia ariſing from exceſſive fatigue, by a long march in hot weather. Gui. Patin‡ has alſo noticed the occurrence of this diſeaſe from ſimilar cauſes. The German Ephemerides § contain a ſingular caſe of Hydrophobia from the bite of an enraged dog. The caſe is related by the phyſician who attended the patient. Jacob Otten, having chaſtiſed a dog

* Epiſt. prius cit. Art. 31.

† Tom. 7. Juillet. An. 1757. p. 3 & ſuiv. Tom. 8 Aöut. p. 81, p. 1757.

‡ Tom. 1. p. 275. Tom. 3, 169.

§ *Ephem. N. C.* An. 6. *Ob.* 9. *p.* 187.

dog which had devoured a favourite hen, was bitten by the animal in the wrift. He was vifited by his phyfician on the following morning. The patient complained of great ftricture and anxiety about the breaft; his countenance appeared ftern and diftreffed; the tongue and throat were dry and parched, but not the flighteft inflammation was vifible in thofe parts. Although at firft he was able to bear the fight of liquids, he now fhuddered at them with extreme averfion. He declared fome time after when preffed to drink, that he was not able, without feeling the moft excruciating torments, to look upon, much lefs to fwallow liquids. The wound had healed during the time he fuffered thefe complaints. He died about the fixth day of the difeafe. The dog was not mad, as he was alive and well long after the patient died. Another cafe defcribed in the fame work,* by Doctor J. B. Scarramuchi, claims a particular attention, on account of the fymptoms being fo ftrongly marked. A young man, in a paroxyfm of rage from fome domeftic troubles, bit the index finger of his left hand, at about eight o'clock in the evening. On the next day at four o'clock, P. M. he was feized with flight fhiverings, accompanied with a vomiting of bile. At this period he expe-

 rienced

* An. 9. in Append. p. 249.

rienced a dread of water,* and every other kind of liquid—nor was he able to bear the ſight of poliſhed and ſtrongly illuminated objects. To ſuch a degree was the abhorrence of water felt, as to occaſion a ſenſe of ſuffocation at the bare mention of it. He afterwards became delirious, ſpitted upon the by-ſtanders, and was with difficulty reſtrained by violent coercion from injuring them. He vomited large quantitis of bile, and a dark coloured fluid. His ſtrength ſunk gradually, and he expired in the ſpace of a few hours.† Johan. Hen. Brechfeld has related the caſe of a gentleman, who was ſeized with hydrophobia in ſo violent a degree, as not to be able to ſwallow the ſmalleſt portion of any liquid. He had no difficulty in ſwallowing ſolids. On the third day of the diſeaſe he ſpitted at the by-ſtanders; and ſuddenly expired in his chair on the next day, after an attack of one or two general convuſions. Upon a ſtrict enquiry being made into the cauſe of his complaint, and particularly with reſpect to his having been at any time expoſed to infection from

* "Verſus horam 16 aquam, omnemque alium liquorem, "necnon corpora lucida et candida abhorreſcere incepit, "ita ut etiam ad aquæ mentionem ſtrangulari videretur."

† Act. Hafniens. An. 1682.

from a mad animal; he declared, when perfectly rational, that he could not recollect ſuch an event to have happened;* nor was he able to aſſign any cauſe for the origin of his diſorder. I conſider the following caſe related by Dr. M. Liſter,† as deſerving particular notice. If it be not conſidered an inſtance of Hydrophobia, occurring without the agency of the canine poiſon, we muſt be compelled to grant, that the bite of a dog proved infectious when no ſymptoms of diſeaſe had appeared in the animal at the time the wound was inflicted, nor for ſix weeks afterwards. The writer of the caſe has not made us acquainted with the fate of his animal at any ſubſequent period. Now that a rabid dog ſhould be capable of communicating the infection, previous to any ſymptom of the diſeaſe having diſcovered itſelf, is in direct oppoſition to general opinion. It is likewiſe equally repugnant to particular experience,‡ and to the analogy to be obſerved

 in

* "An a cane rabido demorſus unquam fuerit? A me "interrogatus (cum mente adhuc conſtanti) ſe id non "meminiſſe aiebat."

† Tract. de morbis quibuſdam chronicis. Hiſtor. I.

‡ In order to obtain ſatisfactory information on this point, I wrote to Hugo Meynell, Eſq. whoſe knowledge on the ſubject of the diſeaſes of dogs muſt be ſuperior to moſt others,

in the operation of most other infectious diseases. Besides, the length of time (above six weeks) from the bite to the death of the patient, exceeds the general period assigned for the fatal termination of madness in dogs. Doctor Hunter,* in his ingenious paper on this subject, observes, that the disease generally proves fatal to dogs *in three weeks*. Is it not then a little extraordinary, that Doctor M. Lister should have expressed no doubts, relative to the power this dog had of communicating the infection, when he confesses the animal appeared free from any symptom of madness, at the time the patient

others, from his long experience and attention to whatsoever regards their health and safety. He obligingly returned the following answers, to some queries I had proposed. —— 1st. "Madness generally appears between a "month and six weeks after the bite; about a fortnight is "the shortest, and eight months the longest period I have "known it to appear in after the bite." 2d. "I know no "instance of a dog apparently in good health having com-"municated the disease; but I have known the disease to "have been communicated by a dog that, to one who was "not a nice observer, or was not well acquainted from "experience with the symptoms of canine madness, might "have appeared in perfect health." 3d. "I am not "acquainted with any instance of a dog having apparently "recovered, and then relapsed, after the symptoms of "the disease had once appeared."

* See Transactions of a Society for the improvement of medical knowledge, vol. i. p. 295.

patient died?* I ſhall quote ſuch paſſages, from the hiſtory of this caſe, as will certify, beyond diſpute, the identity of the ſymptoms with thoſe uſually exhibited in canine madneſs. A young man was ſlightly bitten in the arm by his own dog. The animal returned quietly home with him on the ſame evening. The wound was ſuffered to heal ſpontaneouſly. About forty days after the accident happened, the patient was ſeized with flying pains over his whole body; but eſpecially about the region of the præcordia. On the day following he was troubled with a conſtant inclination to vomit, attended with violent twitchings at the ſtomach. With great difficulty he was able to ſwallow his ſaliva. He refuſed to drink ſome water which Doctor Liſter preſented to him. His countenance now exhibited great diſtreſs. He was able to ſwallow ſolid food when preſented in a ſpoon. On the fourth day theſe ſymptoms had increaſed to the higheſt degree: To ſwallow his ſpittle now became ſo dreadfully difficult, as to threaten inſtant ſuffocation. The ſight of water was terrible. Every object inſpired him with dread. His mind was, however,

* "Neque illud ſilentio prætereundum eſt, ipſum canem a "quo morſus eſt, hominem eâ nocte ſecutum eſſe; imo "*ipſe canis vivus et ſanus eſſe* videbatur, quo tempore homo "mortuus eſt."

however, ſufficiently compoſed to frame his will; and he inſpected his book of accounts. He had no ſuſpicion of the nature of his complaint until Doctor Liſter made ſome enquiries. On the ſame evening he expired ſtrongly convulſed, immediately after making an effort to ſwallow ſome beer.

The frequent occurrence of an averſion to fluids, and of great difficulty in ſwallowing them in women affected with Hyſeria, has been noticed by many writers.* Some of theſe facts demonſtrate, that all the ſymptoms of canine madneſs have been brought on by violent affections of the mind, in irritable and delicate habits. The fatal termination of ſome of theſe inſtances, tends further to confirm the ſtrictneſs of the analogy between canine madneſs and hyſteria. Platerus † takes notice of a ſingular inſtance of hydrophobia in conſequence of terror. A woman, of an irritable ſtate of nerves, was much alarmed at being left alone by her companions on the banks of a river, where ſhe had been employed in waſhing linen. As the evening approached, her fears increaſed. After returning home ſhe was ſeized with a violent ſobbing, and was almoſt in danger of ſuffocation. Theſe ſymptoms increaſed daily;

* MORGAGNI, MEAD, SCHENKIUS, PLATERUS, &c.

† *Obſerv. Med.* PLATER. *Lib.* 1.

daily; and an utter averſion to fluids ſupervened. The motion of the air, and the appearance of luminous objects, were equally offenſive. She expired under the preſſure of theſe ſymptoms on the eighth day of the diſeaſe. Sauvages * has recorded a fatal example of hydrophobia in a young woman, in conſequence of the mind being violently agitated, during a morbid and irritable ſtate of the body. In this patient, the ſight of any kind of fluid produced dreadful convulſions, and it was not poſſible to prevail upon her to ſwallow any medicine. The patient died three days after the accident. A variety of caſes might be cited, in proof of the ſtrict ſimilarity between the ſymptoms of Hyſteria and Rabies Canina from the Ephemerides N. C. I ſhall content myſelf, however, with having

* "Une ſervante ayant été vivement preſſée par un "jeune homme dans le temps de ſes règles, cette evacua-"tion s'arrêta, et quelques heures après, le jeune homme "ayant renouvellé ſes tentatives, la fille entra dans une "eſpéce de fureur. Dès ce moment elle ſe plaignit de "douleurs vagues par tout le corps, et ces douleurs furent "ſuivies d'une fièvre ardente, et d'un delire ſi violent, "qu'il fallut lier la malade. Ces accidens furent ſuivis "de *l'hydrophobie la plus decidèe.* A la vue de toute eſpèce "de liquide, la malade tomboit dans des convulſions "affreuſes; elle rejetoit juſqu' aux alimens ſolides, et il "ne fut pas poſſible de lui faire aucun remede. Elle mourut "trois jours après ſon accident."

Sauvag. *Noſol.*

having ſtated the above; and proceed to draw ſome inferences from the general recital of preceding facts.

I. That the poiſon of a rabid animal may lay dormant in ſome inſtances for the period of twelve, and even twenty months: yet that the caſes related by various authors, where canine madneſs is ſaid to have occurred at the diſtance of *ſeven*, *twenty*, and *forty years*, from the communication of the poiſon, may be juſtly conſidered as either inſtances of ſpontaneous hydrophobia, or of ſuch diſeaſes as occaſionally exhibit the anomalous ſymptoms—of an inability to ſwallow fluids, and an averſion at the ſight of them:—The poiſon of a mad animal has had no ſhare in their production. II. That the mere application of the ſaliva of a rabid animal to the ſkin, eſpecially to thoſe parts where its ſtructure is of a thin and delicate texture; ſuch as the lips, tongue, &c. has produced the diſeaſe of canine madneſs; but that the inſpiration of the breath of a mad animal by any perſon, has ever produced this complaint appears highly improbable, and is not ſupported by poſitive facts. III. That local irritation from wounds in irritable habits, eſpecially when conjoined with a perturbed ſtate of the paſſions; and, alſo violent affections of the mind, independently of corporeal injury, in hyſterical and hypochondriacal conſtitutions, have

have produced all the pathognomonic ſymptoms of canine madneſs; and finally, that violent alternations of heat and cold, and all other cauſes, which induce great debility, and at the ſame time increaſe the irritability of the ſyſtem, have at times proved adequate to the production of ſymptoms, exactly correſponding with thoſe of Rabies Canina. Perhaps the following obſervations may tend to elucidate, more fully, the propriety of adopting the above inferences.

I. I conjecture that thoſe writers who noticed the occurrence of canine madneſs at the diſtance of ſeven, twenty, and even forty years, from the ſuppoſed communication of the virus, have either been miſtaken, in conſidering the anomalous ſymptom of an inability to ſwallow fluids, which is ſometimes met with in fever, hyſteria, and other diſeaſes, as an effect of the animal poiſon; or have been ignorant that Hydrophobia has occurred in particular habits, without the poſſibility of aſſigning any ſpecific cauſe for its production. Moreover, it is a fact founded on the obſervation of a conſiderable number of caſes, that upon the average, not more than one* perſon, out of twenty-five who

* See Hamilton's Treatiſe on Hydrophobia; Dr. Vaughan's "Two Caſes of Canine Madneſs;" and Dr. Hunter's Paper on this ſubject in the Tranſactions already quoted.

have been certainly expofed to the bite of a mad dog, has become infected with the difeafe. Therefore, when fymptoms of Hydrophobia have appeared at the diftance of many years from the bite of an animal really infected, no pofitive conclufion can be drawn from this circumftance; as the difeafe is by no means a certain confequence of the bite. II. Notwithftanding the hoft of negative facts which may be brought to difprove the occurrence of infection from mere contact of the faliva with the fkin, yet the pofitive facts already quoted from good authorities are of fuch force, as to ftamp conviction on the mind, of the poffible, though rare occurrence of canine madnefs from this caufe. If this conclufion be juft, may we not imagine in fome cafes, where the poifon is faid to have manifefted itfelf after a very long interval from the bite of a rabid animal; and, indeed alfo in fome of thofe cafes which have been confidered altogether as fpontaneous, that the poifoned faliva may have been *recently* communicated, either indirectly, through the unfufpected medium of the cloaths, or directly, by fondling* or

* It is not poffible to ufe too ftrict precaution in avoiding a familiarity with ftrange dogs. Dr. Hunter, in the work before alluded to, has remarked, that almoft all the accidents related to the fociety arofe from taking notice of ftrange dogs.

or playing with an animal, not known to have been rabid? That ſuch accidents very rarely occur, will be readily granted; yet, as they ſeem to be within the limits of probability, an important leſſon is held forth to medical practitioners, not to neglect thoſe caſes where the ſaliva has been communicated merely to the ſkin, without any viſible injury being ſuſtained. III. The hiſtories of Hydrophobia, related by different Authors, as ariſing from local irritation of wounds, or from violent affections of the mind, operating ſuddenly and powerfully on the nervous ſyſtem, merit a due conſideration. The credibility of theſe hiſtories ſeems not only to be confirmed, but alſo the ſtrict analogy between their ſymptoms and thoſe of canine madneſs to be farther illuſtrated, by the occurrence of Hydrophobia in ſome caſes of Tetanus. Facts of this kind have been obſerved, and commented upon, by two celebrated Phyſicians.* Doctor Ruſh† has remarked the joint ſimilarity of ſome ſpecies of Tetanus, with Hydrophobia. Having particularly noticed the ſymptoms of irritability and debility—and the ſenſe of ſtrangulation felt on ſwallowing liquids—as occurring in both maladies, he juſtly inferred, that theſe diſeaſes were nearly related in their proximate cauſe of ner-

* Dr. Percival and Dr. Rush.

† Eſſay on Tetanus—Medical Inquiries, v. 1.

vous irritation, and therefore required the ſame mode of cure. With equal ſagacity, and by a ſtriking coincidence frequently to be met with among men of talents and obſervation, Doctor Percival* had pointed out the ſame reſemblance between theſe diſeaſes, and had alſo ſuggeſted a ſimilar mode of cure, previous to the publication of Dr. Ruſh on this ſubject. Both theſe Authors have produced ſeveral caſes to confirm their opinions. The following ſtriking inſtance of ſimilitude between Tetanus and Hydrophobia was communicated to me by Dr. Percival. The caſe occurred ſince the publication of his valuable obſervations on canine madneſs, and was ſent to him through the medium of Doctor Haygarth. Mr. Wilmer of Coventry, well known by his many ingenious works, attended the patient, and furniſhed the deſcription of the caſe.—" A young gentleman, pupil to a Sur-" geon of this town, had the middle finger " ſlightly wounded by a ſplinter of wood, on " its internal edge, and juſt over the part where " a nerve accompanies the artery to the end of " the finger. In about a week the little wound " healed. A day or two after, he complained " of a ſtiffneſs in his throat and neck. This he " attributed to his having taken cold. The " complaint

* Eſſays Med. and Experim. vol. II.

" complaint increafed, and extended to the
" mufcles of the face and jaw. The mufcles
" which move the lips were affected with fpafms.
" A pain was felt about the fcrobiculus cordis.
" In three days the lower jaw was locked. The
" convulfive motions of the mufcles of the face
" recurred only at intervals. He had taken, dur-
" ing the three firft days, Tincture of Opium
" with Camphor Julep, in large quantities. On
" the third day his lower jaw was lefs fixed, but
" he could take no more of his fluid medicine;
" and all watery drinks he found impoffible
" to fwallow. Whenever they approached his
" mouth, the convulfive fpafms of the face re-
" turned, and his head was forcibly drawn
" backwards. He was now ordered opium in
" a folid form, which was perfevered in with-
" out effect. Clyfters of afafætida, opium, &c.
" were repeatedly given. The nerve leading to
" the part affected was divided tranfverfely with
" the knife. On the fifth day he appeared fome-
" what better, when we were haftily called to
" him, as he was fuppofed to be dying. Uni-
" verfal convulfions, (during which the mucus
" was plentifully collected in the corners of his
" mouth) feized him. In the fpace of twenty
" minutes the fpafms ceafed. Electricity was
" propofed, and tried. After he had received
" a few fhocks, the convulfions returned, and

" in

"in less than ten minutes he died. Doctor "Simson, Mr. Cole, and Mr. Whitwell, as "well as myself, attended him; and we were "all of opinion, that if the symptoms I have "described had followed the bite of an animal, instead of the injury done to his finger "by a splinter of wood, we should have had "some difficulty in determining whether the "disease was Tetanus or Hydrophobia. About ten years since I attended a patient, whose "symptoms were nearly similar to those above "related, and which were the consequence of a "bite from a horse. After opium, and other "antispasmodics, were ineffectually tried, he "recovered by the use of electricity."

If there were any necessity for additional proofs of the occurrence of Hydroyhobic symptoms, in cases of local injury, a variety of instances might be brought forward, from Hildanus, Cœlius Aurelianus, Schenkius, and other writers. But the fact seems to be sufficiently established. It appears then, that the occasional causes productive of spontaneous Hydrophobia, operate either locally or generally upon the nervous system, by increasing its irritability, and at the same time inducing debility. It is also sufficiently evident, that the action of the canine poison produces similar effects. But its superior mischievous activity, in comparison with any other occasional

cause,

caufe, cannot be denied. Yet I apprehend we ought to attribute the more fatal virulence of the canine poifon, rather to the difference in degree, than in the nature of the caufe. For undoubtedly, the identity of effect warrants the conclufion of an identity of the caufe. Happy would it be for the patient, as well as grateful to the practitioner, if farther practical experience in the mode of cure, fhould confirm the truth of the above inference!

In the *Act. Norimberg.* Tom. II. there is a cafe of Hydrophobia related, in which all the fymptoms of canine madnefs were combined with Hyfteria. A cure was effected by the exhibition of tonic and antifpafmodic medicines. Doctor Nugent's extraordinary cafe of Hydrophobia affords a fimilar proof of the efficacy of thefe remedies.

In both thefe inftances, the fymptoms appeared altogether in as violent a degree as in any cafe of canine madnefs. We may then rationally expect, that application and perfeverance will at length difcover a remedy fufficiently powerful to counteract the virulent effects of the canine poifon.

From a review of the whole of the preceding facts and obfervations, are we to confider the unhappy cafe prefixed to this enquiry, as arifing from the bite of a rabid animal, inflicted twelve

years

years since; or may we, with more probability, attribute the disorder to some unobserved or forgotten communication of the canine poison with the skin; or, finally, must we not be compelled to view this case as a genuine instance of spontaneous Hydrophobia? It is with diffidence that I incline to the last opinion. But when I reflect that we have no authentic testimony of the canine poison lying dormant more than twenty months at farthest; that Hydrophobia, with all the pathognomonic symptoms of Rabies Canina, has been produced by other occasional causes than the infection of a rabid animal; and also that notwithstanding a person should have been really exposed to the canine poison, the chances are greatly in favour of his not being infected —I am compelled to conclude, that this patient fell a victim to other causes, than the poison of any rabid animal. Nor do I conceive that the effects detailed in this case are disproportionate to the power of the supposed causes. We ought to consider the melancholic temperament of this patient, so much predisposed to mental and corporeal irritation—the weight of his affliction at the heart-rending prospect of his family's distress—his unremitted, but ineffectual efforts to remove these calamities—and the scanty portion of sustenance he allotted to himself, during this almost unexampled struggle of

strenuous

ſtrenuous exertion, againſt famine, debt, and deſpair! Add, to theſe circumſtances, the effects of imagination in aggravating the violence of the diſeaſe. For, although the patient's dread of liquids did not ariſe from this cauſe, as he felt a difficulty in ſwallowing them previous to being impreſſed with a remembrance of his having been bitten by a ſuppoſed mad dog, yet the moment this idea took poſſeſſion of his mind, he conſidered his recovery as hopeleſs. The image of the dog haunted his imagination with perpetual terrors; and the expectation of a violent death, by being ſmothered, (a vulgar and unjuſt perſuaſion too often entertained) would not a little tend to increaſe the nervous irritation already excited. I have before mentioned, that this caſe, from the diſeaſe being in a very advanced ſtage, was conſidered as irremediable. Nevertheleſs, ſuch remedies were adminiſtered as are uſually recommended in the cure of this complaint. Among theſe the external and internal uſe of oil were tried; but indeed, at ſo late a period, as not to afford any great expectation of relief being obtained. It may not be improper to mention here an idea that occurred to me on reading the two caſes related by Doctor Shadwell,* in which he truſted ſolely to the exhibition of this remedy. In one inſtance it

 proved

* Memoirs of the London Medical Society—laſt vol.

proved ſucceſsful, but failed in the other. Dr. Shadwell attributes its failure in the caſe of the the boy, to the difficulty he experienced in ſwallowing it, joined to an extreme repugnance to make the attempt; ſo that only a very ſmall portion (in compariſon with what the man took) could be forced down. As this difficulty of ſwallowing fluids, and conſequent averſion to them, ariſes from the morbid irritability of the fauces, and muſcles ſubſervient to deglutition, I conceive, that the impediment to the uſe of oil, (as well as other fluids,) might be overcome, by adopting the ſame mode of adminiſtering it, as was practiſed by the late Mr. John Hunter,* to convey food into the ſtomach of a patient, who

* "The inſtrument made uſe of was a freſh eel ſkin of "rather a ſmall ſize, drawn over a probang, and tied up at "the end where it covered the ſponge, and tied again cloſe "to the ſponge where it is faſtened to the whale bone, "and a ſmall longitudinal ſlit was made into it juſt above "this upper ligature. To the other end of the eel ſkin "was fixed a bladder and wooden pipe, ſimilar to what is "uſed in giving a glyſter, only the pipe large enough to "let the end of the probang paſs into the bladder without "filling up the paſſage. The probang thus covered was "introduced into the ſtomach, and the food and medicines "were put into the bladder, and ſqueezed down through "the eel ſkin But as caſes of the kind may occur "where eels cannot be procured, a portion of the gut of "any ſmall animal, as a cat or a lamb, will make a very "good ſubſtitute." Hiſtory of a caſe of Paralyſis, &c. in the Tranſactions already quoted.

who was afflicted with a Paralyfis of the Œfophagus, and confequently was unable to fwallow any nutriment. By this mode the oil could not come in contact with the irritable parts of the gullet, but would immediately enter into the ftomach, and thereby afford to the patient that chance of relief which the remedy has been faid to have effected, at leaft in one inftance. It is well known that the Antients relied greatly upon the ufe of this remedy. Cœlius Aurelianus,* among other antient writers, recommends its ufe; but was aware that in moft cafes it could not be fwallowed, and therefore orders its exhibition by another mode.

Since I entered on the difcuffion of this part of my fubject, I have read with great fatisfaction an account,† by J. Williams, Efq. of the furprifing efficacy of a remedy againft the deleterious effects of the bite of feveral fnakes; and efpecially of the Cobra de Capello. Thefe facts are not only interefting, as pointing out a certain and fimple mode of refcuing thofe expofed to the bite of thefe venomous reptiles, from almoft inevitable death, but alfo highly deferv-

 ing

* "Quod ita facere poterimus, fi calidam atque oleum "clyftere per podicem injiciamus; et fi fieri poterit, diur- "nis diebus, parvum quidem tunc enim poterit contineri."

Cœl. Aurel. *lib.* 3, 231, *de morb. acut.*

† Afiatick Refearches, vol. II. p. 323.

ing attention, as they demonſtrate an analogy between the ſymptoms ariſing from the poiſon of ſome ſnakes, and thoſe produced by the bite of a rabid dog. And ſurely, in the treatment of ſo fatal a diſeaſe as canine madneſs, it is proper to adopt any method of cure founded upon rational principles. Analogy, under theſe circumſtances, ſeems to be our ſureſt guide.

The author of this diſcovery has detailed ſeveral caſes, ſelected from a variety of others, which terminated with equal ſucceſs. His method of cure entirely conſiſts in the external application to the bitten part, and internal exhibition, of the ſpirit of the cauſtic volatile alkali.* Eau de Luce (which is generally at hand) anſwers as well; but he, with reaſon, prefers the pure cauſtic Alkali, when it can be readily met with. This remedy has uniformly put a ſudden ſtop to the baneful effects of the poiſon of the Cobra de Capello.

The action of this poiſon ſeems to be chiefly confined to the nervous ſyſtem, and reſembles that of the canine virus, in exciting convulſive ſpaſms about the throat and fauces,† difficulty in

* The "*Aqua ammoniæ puræ*" of the College Diſpenſatory.

† Caſe 2d. p. 325.

" In July 1782, a woman of the Brahmen caſt, who " liv in my neighbourhood at *Chumar*, was bitten by a

in ſwallowing, and a flow of ſaliva from the mouth. Whether the remedy acts ſpecifically, by deſtroying the quality of the poiſon, or generally, by ſtimulating the nervous ſyſtem, cannot with certainty be determined. But I am inclined to adopt the latter opinion. At all events it is abundantly proved, that the effects of a moſt deadly poiſon (which acts violently on the nerves) have been counteracted by the operation of a certain medicine. There is, therefore, ſufficient reaſon to hope, that its exhibition in canine madneſs may be attended with ſalutary effects. For, if two diſtinct kinds of poiſon, generated by different creatures, produce ſimilar phænomena in the human conſtitution, we may fairly conclude that theſe effects originate from the ſame proximate cauſe. There will certainly be great, if not inſuperable

"Cobra de Capello, between the thumb and fore-finger of "her right hand: prayers and ſuperſtitious incantations "were practiſed by the Brahmens about her till ſhe became "ſpeechleſs and convulſed, with locked jaws, and a pro-"fuſe diſcharge of ſaliva running from her month. On "being informed of the accident, I immediately ſent a "ſervant with a bottle of volatile cauſtic alkali ſpirit, of "which he poured about a teaſpoonful, mixed with water, "down her throat, and applied ſome of it to the part "bitten. The doſe was repeated a few minutes after, when "ſhe was evidently better, and in about half an hour was "perfectly recovered."

able difficulty, in adminiftering cauftic volatile Alkali Spirit (neceffarily diluted with a portion of fome mild and infipid liquor) in Hydrophobic cafes, where the increafed fenfibility of the fauces to irritation, and the dread of liquids, are fo ftrongly felt. Perhaps it would be advifable, in fuch cafes, to mix the volatile alkali with crumbs of bread, and form the mafs into boluffes; or rather, to exhibit the cauftic volatile falt enveloped in wafer paper. By this latter method the pungency of the medicine would be concealed, and its form might enable the Patient to fwallow it with greater facility.

Before I conclude this fubject, I cannot avoid hinting at the neceffity of adopting fome general plan, for preventing the communication of the canine virus by infected dogs, to animals of the fame fpecies. The great increafe* of mad dogs, and the confequent ravages of canine madnefs among the human fpecies, during the courfe of the prefent year, (1794) demand the ferious and fpeedy attention of the Legiflature. For I conceive Government alone to be capable of eftablifhing a plan of prevention on fo extended a fcale, as may afford a rational profpect of totally eradicating this dreadful malady. Nor is

* No lefs than forty perfons applied to the Infirmary at Manchefter, in the courfe of a fortnight, who had been bitten by dogs undoubtedly mad.

is the project fo hopelefs as might, on a flight confideration, be imagined. If the fact be fufficiently eftablifhed, which Mr. Meynell has afferted from experience—That he preferved his Kennel from canine madnefs for a feries of years, by making every new hound perform quarantine for a certain time, previous to his admiffion among the pack,* it forms a ftrong prefumption that the difeafe is ALWAYS produced by an actual communication of the poifon of an infected animal. This conclufion is farther ftrengthened by the well-attefted fact, mentioned by Dr. Hunter, and other writers,† of canine madnefs not having been known to exift in the Ifland of Jamaica, for the fpace of forty years. The diftance of this ifland from the Continent is the probable caufe of its freedom from the complaint. For, if the canine poifon difcovers itfelf in dogs within three weeks or a month, its importation into the ifland would be prevented by the death of the infected animal during the voyage. As it appears then highly probable, that canine madnefs can only be produced by an actual communication of the poifon of an infected animal, would not an Act of the Legiflature, ordering all dogs to be carefully confined for a certain time (fix weeks would probably be fufficient)

* See Dr. Hunter's paper in the "Tranfactions," &c.

† Confult Dr. Mofely's Treatife on the difeafes of tropical Climates, &c.

ſufficient) prove adequate to the prevention of the diſeaſe, without having recourſe to the ſo frequently ſuggeſted, but certainly cruel and nugatory method, of deſtroying, (or rather of taxing ſo as to cauſe to be deſtroyed) the majority of dogs in the kingdom?

Farther EXPERIMENTS *and* OBSERVATIONS *on the* VEGETATION *of* SEEDS. *By Mr.* JOHN GOUGH. *Communicated by* DR. HOLME.

READ, DECEMBER 12, 1794.

IT was remarked, in the concluding paragraph of my former paper on this ſubject, that ſeeds, ſoaked in water and confined in ſmall quantities of air, do not always loſe the faculty of vegetating. At the ſame time it was hinted, that this difference ariſes from the changes, which are conſtantly taking place in the temperature

perature of the atmofphere, and confequently in all bodies furrounded by it. I fhall now endeavour to prove experimentally the truth of what I formerly advanced as a probable conjecture, by fhewing that the vegetative principle in feeds is deftroyed by the putrefactive fermentation; and that the commencement of this procefs depends on the changes in queftion being accelerated or retarded, as the temperature increafes or diminifhes.

Experiment X. Jan. 31ft. 1794.—Three ounces of dry peas were put to foak in rain water: February 2d. four drams of the peas, which had now been fteeped forty-eight hours, were removed into a phial, which was then filled with water, and inverted in an earthen jar of the fame: that part of the bottle which was out of the veffel being fcreened from the light by a cafe of brown paper. It was then placed, in a window looking to the North, (where a thermometer was hanging) clofe to the veffel containing the water, in which the remaining part of the three ounces was immerfed.

At the fame time, I placed two drams of the peas, thus foaked, in a phial; and removed them to a much warmer room, where they foon vegetated. The fame was repeated, with equal fuccefs, at the end of every forty-eight hours, to the eighth.

In the mean time the thermometer was be-

tween 38° and 48°, being commonly at 43°. The bottle remained full of water to the ſixth; but the weather then became warmer (the thermometer ſtanding at 46° or 48°), and two large bubbles of air were ſeen in the upper part of the glaſs on the eighth. Theſe bubbles were ſomewhat larger on the tenth; and nearly two dram-meaſures of air occupied the higher part of the inverted phial on the twelfth.

The uſual quantity of peas, viz. two drams, placed in a dry bottle, on the evening of the tenth, ſhewed hardly any ſigns of vegetation on the 13th. (thermometer from 46° to 48°): but, on the 15th. ſix, out of ſeventeen, had produced ſprouts. An equal quantity of the peas which were yet lying in the water, was treated in the ſame manner on the 12th; but they ſhewed no ſigns of vegetating on the 17th. This is a proof that the peas yet in water had been ſpoiled by putrefaction; the commencement of which was certainly indicated by the air extricated from thoſe in the inverted bottle. The *gas* that was collected by the bottle, in the courſe of the experiment, conſiſted principally of *carbonated hydrogene* mixed with nearly one quarter of its bulk of *carbonic acid gas*.

One circumſtance ſeems worthy of notice, though not ſtrictly applicable to the ſubject of the preſent enquiry. The peas appeared to be

ſaturated

faturated with water at the end of two days: at leaft I judged it to be the cafe from the following circumftances: feventeen of them weighed two drams on the fecond of February; and the fame number came within a very few grains of the fame weight, over or under, to the end of the experiment. Thus it feems clear, that it is a matter of indifference, whether foaked feeds be feparated from the air, by the interpofition of *water* or *azote*; becaufe it is almoft certain, from the preceding remark, that the former fluid has no power to change the nature of them, after they are fully charged with it. It is evident from this experiment, that the putrefactive fermentation, or an emiffion of *gas* from their fubftance, deftroys the vegetative faculty of peas; from which we may venture to conclude, that it has, fooner or later, the fame effect on all other feeds expofed to its influence.

This experiment being made in cold weather, the deftructive procefs proceeded but flowly, and the peas ufed were long in lofing the power of producing. In order therefore to determine how far an increafe of temperature would accelerate the commencement of putrefaction, I repeated it twice during the warmer months of fummer, in a room where the thermometer varied from 60°. to 66°. In the former of thefe

 trials,

trials, a very ſtrong fermentation took place before forty-eight hours were expired; and when a part of the peas thus treated was expoſed to the air, at the end of two days, none of them ſprouted.—In the ſecond, they were not ſo ſoon injured; for a few of thoſe which were tried on the third day vegetated. Thus it appears, that an increaſe of temperature proves injurious to ſeeds ſecluded from the air, by promoting putrefaction in them, and thereby deſtroying their vegetative power.

EXPERIMENT XI. Seeds properly moiſtened emit *carbonated hydrogene* mixed with *carbonic acid*, when ſurrounded with *azote*, as freely as others of the ſame kind do when immerſed in water; for if wet peas or barley be confined in a known quantity of *azote*, as in EXPERIMENT IX. the volume of gas will remain the ſame for a few days, but will begin to increaſe more or leſs rapidly at the end of an indeterminate time; which is longer when the temperature is lower, and the contrary. Hence it is evident, that a portion of freſh gas is afforded by the materials incloſed with that contained in the jar; and thus is the bulk of the given quantity enlarged. Moreover, if a bottle charged as in EXPERIMENT VIII. be left cloſely ſtopped, for twelve or fourteen days, in a moderate temperature, the common air contained in it

will

will be firſt rarefied, as we have proved before; but its denſity will in a ſhort time begin to increaſe again from the gas emitted by the wet grain, as will appear if the inverted bottle be opened under water: for, upon removing the ſtopper, a quantity of elaſtic inflammable fluid will ruſh from the neck immediately, which will be ſucceeded by a diſcharge of bubbles of the ſame kind. Hence it appears, that the putrefactive fermentation deſtroys the vegetative power of ſeeds ſurrounded by *azote* or covered by water: conſequently the preſence of *oxygene* is neceſſary for preventing this deſtructive proceſs; which it does by producing another, that may be called the *vegetative* fermentation.

The reaſon why one of the two kinds of fermentation in queſtion always takes place, in ſeeds prepared by ſoaking, ſeems to be this: the water, thus introduced into their compoſition, changes that proportion of their component parts, which is required to preſerve them in a ſound ſtate. If they be then expoſed to the atmoſphere, the action of its *oxygene* awakes the faculty of vegetation in them. On the contrary, when they are ſurrounded by *azote* or water, which do not appear to act on them, the component particles in their texture are left to form new combinations among themſelves, and are partly converted into *gas*; the appearance of which indicates the commencement of that ſtage

of

of putrefaction, by which the faculty of vegetating in the atmofphere is deftroyed. We may now venture to explain, on rational grounds, a curious circumftance alluded to in my former Paper, (page 310): I mean a property, which the feeds of particular plants poffefs, of continuing found and uninjured in the ground for many years, provided it remains fallow; but which vegetate vigoroufly as foon as the foil is pulverized by the plough. For it has been fhewn, that an increafe of heat accelerates the putrefaction of seeds charged with water and deprived of air; from which it may be fafely inferred, that the prefervation of thefe bodies may be infinitely prolonged, by fecluding them from the atmofphere, in a fituation where the temperature never exceeds a certain degree, which is not the fame for all feeds, but depends on their refpective properties. Thus, for example, though peas immerfed in water lofe the faculty of producing in ten or twelve days, when the thermometer is between 40° and 50°, and much fooner in warmer weather, we are not to conclude that all other feeds are as quickly rendered ufelefs in fimilar circumftances. For I repeated the tenth experiment in July, with feveral kinds, in a room where the thermometer was commonly higher than 62°; when it appeared that Barley began to putrify on the fourth day; Wheat

Wheat on the ſixth; white Muſtard-ſeed on the eleventh; but Beans, treated in the ſame manner, continued ſound and vegetated at the end of three weeks. Hence no one has a right to affirm, without actually making the experiment, that the ſeeds of Broom, Cockle, and many more plants that might be enumerated, would be ſoon deprived of the vegetative principle. On the contrary, we may venture to aſſert, that, if ſuch ſeeds will not putrify with the ſummer temperature of the ground, at the depth of five or ſix inches, when placed out of the reach of the air, they will immediately vegetate upon being again expoſed to its influence. This is at leaſt a plauſible explanation of the phænomenon in queſtion. But in order to put it to the teſt of experiment, I took ſome ſeeds of Broom, which had been ſoaked for three days in water, on the fifteenth of Auguſt; and, after mixing them with moiſt ſand, filled a ſmall phial with the mixture. The phial, being well corked and wrapped in paper, was kept to the thirteenth of September, in a room where the thermometer was commonly at 65° and ſometimes roſe to 70°. Theſe ſeeds, being planted afterwards in a pot filled with earth, vegetated.

Experiment XII. On the nineteenth of January, I put a quantity of Onions, weighing

four

four ounces Troy, into a quart bottle containing common air; and introduced, at the ſame time, two ſmall bulbs of the ſame kind into another bottle of equal capacity. The veſſels were then ſecurely ſtopped, the corks being covered with wax and pieces of wet bladder. The two bulbs, that were incloſed apart, began to vegetate before the end of March; and had ſprouts nearly three inches long, before the middle of April: No ſigns of vegetation ever appeared in the larger parcel. The two bottles were opened on the twenty-ſecond of May, being firſt inverted in water, when a quantity of gas, containing a conſiderable portion of *carbonic acid*, iſſued from both of them; particularly from that where the onions weighing four ounces were lodged, which continued to diſcharge numerous bubbles of a fœtid elaſtic fluid through the water, for more than a quarter of an hour, which was as long as I attended to the ſubject. The ſprouts of the two bulbs were flaccid, and evidently in a ſtate of decay: their vegetation undoubtedly ceaſed when the *oxygene* in the bottle was conſumed; upon which the putrefactive fermentation commenced, and deſtroyed their texture. The Onions of the other parcel did not vegetate when expoſed to the atmoſphere, but became ſoft and rotted. The great diſcharge of gas, which took place when the bottle

was

was firſt opened, proves that they were prediſpoſed to putrify, the elaſtic matter being compreſſed in their pores ſolely for want of room to expand in; and the ſubſequent part of the experiment ſhews, that they were too much injured to be reclaimed by the action of the air.

EXPERIMENT XIII. About the middle of February I placed two ſmall onions, on a muslin ſtrainer, in a glaſs jar which contained *azote* and ſtood in water. They remained in this ſituation nearly ſix weeks without altering the leaſt in appearance, though ſome bulbs of the ſame kind, ſtanding in an open glaſs on the ſame ſhelf, vegetated vigorouſly before the concluſion of the experiment. We may venture to infer from the two laſt experiments, that what has been hitherto proved, reſpecting the vegetation of *ſeeds*, is alſo applicable to that of *bulbs*, with this difference: that the former muſt be prepared to make them ſprout, by receiving an acceſſion of humidity from an external ſource, which the latter do not require; becauſe they naturally contain within themſelves a portion of water ſufficient for the purpoſe. Hence it happens that ſeeds, particularly ſuch as are natives of temperate climates, may be conveyed to a great diſtance merely by guarding them from humidity, which cannot be done with bulbs; for they ſoon vegetate, in a proper

 temperature,

temperature, if not deprived of *oxygene*, without which they begin to putrify in a ſhort time.

The preceding experiments relate almoſt entirely to the firſt period of vegetation, during which the rudiment of the future root comes into view from between the ſeed-lobes; and, as this is the commencement of the proceſs, it does not appear improbable that the extraordinary *ſtimulus*, which is required to excite the latent energy of the germ, ceaſes to be of uſe as ſoon as the effect is accompliſhed. For a number of experiments, made by that induſtrious Philoſopher Dr. Prieſtley, prove that plants are capable of living and growing in *azote*. From whence it would appear, that a change takes place in their nature, at a period ſubſequent to the commencement of vegetation; which ſuppoſition can only reconcile what has been delivered, in this and my former paper on the ſame ſubject, to the doctrine that has been very powerfully ſupported, by the labors and authority of a man of the higheſt reputation in the philoſophical world. The following article will however prove, that the infant plant does not undergo the alteration laſt pointed out, while the ſeed-lobes ſupply it with nutriment.

Experiment XIV. On the eighth of April, I put twelve peas into *azote*, confined in a glaſs jar inverted in water. They had been previouſly permitted

permitted to ſprout in wet ſand, contained in another pot covered with a lid to exclude the light; and the rudiments of their roots, which appear firſt, were at that time from one inch to one inch and a half long, being undivided and of a conical figure. In this ſituation they remained till the fourteenth, in a window looking to the the Eaſt, without making a viſible progreſs in growth: they were therefore taken out of the jar, and the longeſt ſprout, being compared with a meaſure to which it exactly correſponded on the eighth, was found not to have altered in the leaſt. An equal number of peas, in the ſame ſtate, were placed under a jar containing common air, ſtanding in the ſame window at the beginning of the Experiment. In theſe, vegetation made a viſible progreſs; for the upper extremity of the ſprout appeared in moſt of them on the twelfth, which ſoon aſſumed a green colour, from the action of light: But though the experiment was prolonged to the twenty-ſecond, in which time the roots attained the length of four inches at leaſt and became branched, they ſtill preſerved their primitive whiteneſs. The ſame experiment was repeated between the twenty-ſecond and twenty-eighth of the ſame month, with two parcels of ſprouted beans; and the reſult correſponded exactly to the facts that have now been ſtated.

Experiment XV. Six ſeeds of white muſtard (*Sinapis alba*) were planted, about the middle of March, in a glaſs bottle; the bottom of which was covered with moiſt earth, the upper part being occupied with common air. The mouth was then well corked, and ſecured with cement. The young plants puſhed their tips into view in the courſe of a few days, and appeared in a thriving condition; but began to droop before the end of the week, and died in a ſhort time after. The air was found to be unfit for combuſtion. Probably the wet mould confined in it contributed not a little towards depriving it of its *oxygene*; for the mud of rivers and ponds has been diſcovered to poſſeſs this property in a high degree.

The facts related in the two laſt articles prove, in a clear manner, that ſeeds which have been permitted to grow for a time in the atmoſphere, ceaſe to do ſo when they are ſurrounded with *azote*: whence it may be ſafely inferred, that a germ in the act of vegetation requires to be continually excited by the ſtimulus of *oxygene*. But as ſoon as the ſeed lobes are exhauſted, the young plant is in a ſtate to derive its nutrition from the ground; and then (and not till then) it finds itſelf in a ſituation capable of making future advances, unaſſiſted by the ſtimulus of reſpirable air.

The infant ſprout at firſt ſuffers only a ſuſpenſion of its energy from the abſence of pure air; but if this neceſſary ſupport be withheld too long, it periſhes by the putrefactive fermentation: For if ſeeds treated as in EXPERIMENT XIV. be taken out of the *azote* in which they are confined, at the end of two or three days, they begin to vegetate afreſh with unimpaired vigour; but if their ſtay in the gas be protracted three or four days longer, when the weather is moderately warm, they loſe their natural color, and putrify.

EXPERIMENT XVI. The lively green, which the ſtems and leaves of plants receive from the action of light, cannot be imparted to them, provided the energy of the vegetative principle in them be ſuſpended: for after permitting a number of peas to produce both extremities of their ſprouts in wet ſand covered from the light by an earthen pot, I placed five of them, on the twenty-ninth of April, in an inverted glaſs jar, containing *azote* confined by water; and three in another jar, in which a portion of common air was alſo incloſed by the ſame means. On the thirtieth, the upper extremities of the ſprouts of the parcel laſt mentioned were green; but, though the Experiment was prolonged to the ſecond of May, thoſe in the other glaſs did not exhibit any perceptible alteration in ſize or color.

color. Two of them were now placed in a glafs filled with atmofpheric air, where they were left unobferved to the fifth, at the end of which time the germs had vegetated confiderably; the lower parts of them ftill remained white; but their oppofite extremities had changed to their proper green. It may here be remarked, though the obfervation has but little connection with our prefent enquiry, that the circumftance of the inferior part of the germ in Peas and Beans conftantly preferving its primitive whitenefs, may be confidered as a proof of the roots of Annuals being different in their internal ftructure to Perennials, Shrubs, and Trees; for many inftances have been noted by naturalifts, fome of which are recorded in the fecond volume of Lowthorp's Abridgement of the Philofophical Tranfactions, (Page 673) of the branches of woody vegetables taking root when planted in an inverted pofition, and producing perfect plants in this unnatural pofture: which fhews that the rudiments of all the different fibres appertaining to a complete vegetable are comprifed in a particular part of it, when this is the cafe. But the circumftance juft now mentioned, is a ftrong evidence of a contrary nature in annuals: for, fince the rudiment of the root is not fufceptible of a green color, it is plain that the part in queftion is deftitute of

fomething

ſomething which is natural to the ſtem, and its appendages. Hence we perceive, that though a perennial may by accident become an annual, the contrary cannot poſſibly take place. In the courſe of May I repeated the laſt experiment with Beans; and the event of this trial correſponded exactly to what has been already ſaid on the ſubject. Hence it may be ſafely inferred, that *greenneſs* cannot be imparted to the ſprouts of ſeeds without the joint action of *light* and *oxygene*; in which they are very different from the ſhoots that frequently proceed from maturer plants, when ſecluded from the atmoſphere: for, as theſe grow freely in cloſe glaſs veſſels, placed in a window, and containing water and *azote*, the parts which are recently produced continue to vegetate, in conſequence of their connection with the parent ſtock, and acquire the color in queſtion without the aſſiſtance of reſpirable air, as is evident from the following article:

Experiment XVII. On the ſecond of July, I introduced a ſlip of Spear-mint into a ſix-ounce-phial, in ſuch a direction that the end of its ſtalk remained in the neck. The bottle was then filled with river water; and, being inverted in a veſſel of the ſame, about four ounces of the water were diſplaced by azote: after which the mouth was ſtopped with a cork in the

the veſſel, and a thick covering of cement was applied after the glaſs had been made dry with a cloth. Theſe precautions were uſed with a view to intercept all communication with the external air. The bottle was then expoſed to the light in an inverted poſition, ſo that the extremity of the ſlip was in the water, and its top remained in the incloſed gas. The leaves began to wither in a few days, and a number of freſh ſhoots appeared in their places, both under the water and above its ſurface, before the tenth, which were green and clothed with leaves. This experiment appears to prove clearly that parts, which are in a condition to grow without the help of reſpirable air, can give a green color to ſuch freſh ſprouts as they may chance to produce when ſeparated from the atmoſphere, provided the *light* ſhine on them. We alſo know that the functions of vegetables are but imperfectly performed during the ſun's abſence. They perſpire, upon an average, ten times more in twelve hours of day, than in an equal ſpace of night. When expoſed to a moderate light, they diſcharge *oxygene* freely; this proceſs ceaſes as ſoon as they are removed into the dark. Many herbs fold up their leaves at ſun-ſet, cloſe their bloſſoms, and experience a kind of *torpor* analogous to the ſleep of animals, during which their internal œconomy is ſuſpended.

pended. LIGHT is therefore the chief exciting power, in adult vegetables, which gives activity to their different organs; and hence greennefs, which indicates a plant to be in a healthy ftate, arifes from its juices being properly affimilated; to which the influence of the folar rays contributes, by giving its veffels their neceffary tone. Thus the different fecretions required in its œconomy are elaborated; its fibres receive their juft texture; and the hue, which Nature has diffufed fo univerfally over this part of creation, befpeaks its vigor and profperity. But *oxygene* difcharges that function in feeds, which *light* difcharges in maturer vegetables; and this temporary difference, in the nature of the fame organized body, is a wife precaution: for, fince the germ is intended to expand itfelf in the ground, the author of the univerfe has endued it with properties fufceptible of neceffary impreffions, from a caufe that has free accefs to its dark retreat.

With the affiftance of this agent, it performs a kind of imperfect vegetation; which continues till the rudiment of the ftem breaks the foil and comes into day, where it immediately experiences the influence of the light; which, by producing a change in its colour, gives it the appearance of a plant.

All the preceding conclufions apply folely to plants growing on dry land: for it is evident, from a flight confideration of the fubject, that the œconomy of *aquatic* vegetables confifts of a clafs of habits of a very different nature; which cannot be rightly underftood, until they be inveftigated by a courfe of experiments.

An Attempt to explain the NATURE *and* ORIGIN *of the* ANCIENT CARVED PILLARS *and* OBELISKS, *now extant in Great Britain. By* MR. THOMAS BARRIT.

READ DECEMBER 26, 1794.

ANTIQUARIANS are often accufed of a fuperftitious devotion to the objects of their refearch. The prefent effay will, at leaft, be freed from this imputation; for I intend to fhew, that many ftone monuments in this country have been referred to a period too remote, by thofe who have hitherto examined them.

Some rude maffes of ftone are, indeed, to be feen, particularly on the coafts of Scotland, which were probably erected immediately after battles

battles with the Danes and Norwegians; but I am inclined to believe that all the figured pillars and obelifks, which have been fuppofed monuments of fimilar events, were croffes, either erected on confpicuous places to excite devotion, or raifed over the burying places of noble families, or defigned to commemorate military tranfactions, of a much later period.

The crufades, and the fcience of heraldry, gave birth to multitudes in unnumbered forms, which no one but a ftudent in arms can poffibly have a knowledge of. Indeed an acquaintance with heraldry is, if of no other ufe in thefe days, abfolutely neceffary as an auxiliary to the ftudy of Britifh antiquities; and without it an enquirer is liable to unavoidable difficulties, if not to very great miftakes, fo clofe a connection fubfifts between many parts of heraldry and antiquity. After the barrow and the tumulus of the Pagans, ftone croffes were introduced by the Chriftians. Many of them are at this day in a ftate of great decay, and others entirely gone, their exiftence being only afcertained by the name of the fpot on which they once ftood.

Befides the injury which their ornaments and imagery have undergone from the mouldering hand of time, and wanton ignorance, they have fuffered much from the blind zeal of reformers; who having no tafte themfelves, and being re-

gardlefs of art, under a pretended fhew of piety and of eradicating fuperftition, have totally deftroyed fome, and fo defaced and mutilated others, by breaking off their ornamental and flowered crofs-tops, as to give them the appearance of nothing more than obelifks, or rude pillars. Thus under their prefent form, fome have imagined, that feveral croffes in Britain are the work of northern Pagans, and fuppofed them Runic antiquities of this ifland.

It muft be admitted that fome ancient obelifks may have been confecrated, by the addition of croffes, or other emblems of Chriftianity. Toland, in his hiftory of the Druids, P. 84, fays, "We read of many fuch obelifks thus fancti-"fied, as they fpeak, in Wales and Scotland. "And in our Irifh hiftories, we find the practice "as early as Patric himfelf; who, having built "the church of Donart-Patric, on the brink of "Lock-Hacket, in the county of Clare, did "there on three coloffes, erected in the times "of Paganifm, infcribe the proper name of "Chrift in three languages: namely, Jefus in "Hebrew on the firft, Soter in Greek on the "fecond, and Salvator in Latin on the third."

A little caution ought to be obferved, in decyphering their ornaments, or explaining them to be hieroglyphical; although abundance of imagery, curious grotefque figures, and tracery yet

yet exiſts upon ſome in Scotland; and one at Bew-Caſtle, in Cumberland, had upon it, if it has not now, a verſe, in characters ſaid to be Runic, in good preſervation: But this obeliſk, like ſeveral others, has had its top broken off, and leaves a ſuſpicion behind of its having been once a croſs.

Few perſons at preſent will allow the groteſque and whimſical figures in and on the outſide of our old churches, and upon the margins of our old illumined miſſals, to have any reference to particular perſons or accidents in general, but think them merely the whim of the workman; who, I ſuppoſe, was left to his own choice: for I can ſcarcely perſuade myſelf the clergy of that period would have permitted ſuch exhibitions upon oak, as are ſometimes to be met with under the ſeats of ſtalls, in our cathedral and collegiate churches, had they ſuperintended ſuch works themſelves.

The obeliſks in "Cordiner's Views of Scotland," and that in Nithsdale, deſcribed by Capt. Riddell, one of our late worthy members, and engraved in the memoirs of this Society,* and ſeveral others deſcribed and engraved in Pennant's Tour in Scotland, at Aberlemno, Meigle, and Forres, are all ſculptured with groteſque figures, chain-work, love knots, and ramifying tracery; and where the delineation of

* See Vol. IV. Part I. p. 131.

of a crofs does not fhew itfelf upon any of their fides, the probability of the fummit having once been crucial, does not feem to have occurred to antiquaries.

It is probable that the reformation was the great period of deftruction for the crofs-tops; what was then left ftanding was demolifhed during the civil war.

The three ftone-pillars in the church-yard at Penrith, in Cumberland, a drawing of which I made in the year 1791, and have here given, together with one, reprefenting what I fuppofe might have been their original ftate, have been examined by many; but all have miftaken their original deftination. One fays, he faw nothing in them but "pillars rude from the chifel."

Stukeley, in his Iter Boreale, page 46, fays, "in the church-yard of Penrith is a monument of a giant, Sir Owen Cæfarius, a knight I fuppofe of their king Arthur; two pyramidal ftones, with rude carvings and letters on them, feemingly Runic" — He takes no notice of the four intervening ftones.

Mr. Pennant, in his tour 1769, gives two engravings of thefe pillars: one in their prefent ftate, and the other before the mutilation took place. The pillars in his views are fquare, and figures of boars are carved upon the fide ftones; the drawings of both were fent him by two obliging friends;

friends; but the ſlighteſt obſerver can hardly ſuppoſe, that what is repreſented in the one ever exiſted in the other. Mr. Pennant ſays, "How this great variation in the drawings of the ſame columns happens, is not eaſy to ſay; for it does not appear that there ever were any other in the place. Time has obliterated the figures of the animals; but whether any workman has chiſeled the whole ſhafts of the pillars to their preſent form, is, I think, ſcarcely to be conjectured: they bear all the appearance of antiquity." He ſays again, he has his "doubts about the entire fidelity of the old drawing, which was done about the year 1690." I think there is little doubt of its being a forgery, when compared with the monument.

Another writer repreſents theſe pillars under the character of Boar-ſpears, ſuppoſing they ſtood for the memorial of ſome ancient Nimrod, famous in the chace; and the four flat-ſide ſtones, remaining upon their edges, betwixt them, to be the worn-out ſhapes of boars, or bears, before the Chriſtian æra. The fact ſeems to me to be this; that it is the decayed tomb of ſome now forgotten Cumberland or Weſtmorland Nobleman, with a croſs at the head, and another at the feet, the ſhafts of which only are remaining; and that the four ſtones betwixt them are the remains of the tomb.

The

The pillars are about eleven feet high, and about fifteen feet afunder; the lower parts are round, without ornaments, the upper part of the fhaft terminating pyramidally, and chafed with a fret-work, curioufly interlaced through rows of annulets or rings. Upon one of the tops, on the outfide, are ftill apparent to a nice obferver, the faint remains of a crucifix (not a fimple crofs alone, as given in the above-mentioned tour) which prove it to be chriftian. I was pleafed in this difcovery, as that good judge in thefe matters, Dr. Ferriar, was with me. Upon one of the fide ftones, are ornaments, which are the only tracings, I conceive, that any one can imagine to be runic characters; but when clofely examined, they prove only knot-work, or an imitation of running branches, like the ramifying tendrils of the vine; whereas the letters denominated runic wear no fuch twifted or incurvated appearance: and no fuch figure as a boar could ever have been carved thereon, though time, and fchool-boys play, may have given them their prefent form, in fome degree refembling the back of a hog.

The crucifix above mentioned is placed in the centre of one of the croffes, once furmounting the tops of the pillars, which like the Nithsdale crofs, and that at Bew-Caftle, has

Pl. VI.

T. Barritt del.

P. M. Morland sculp.

MONUMENT in PENRITH CHURCH YARD.

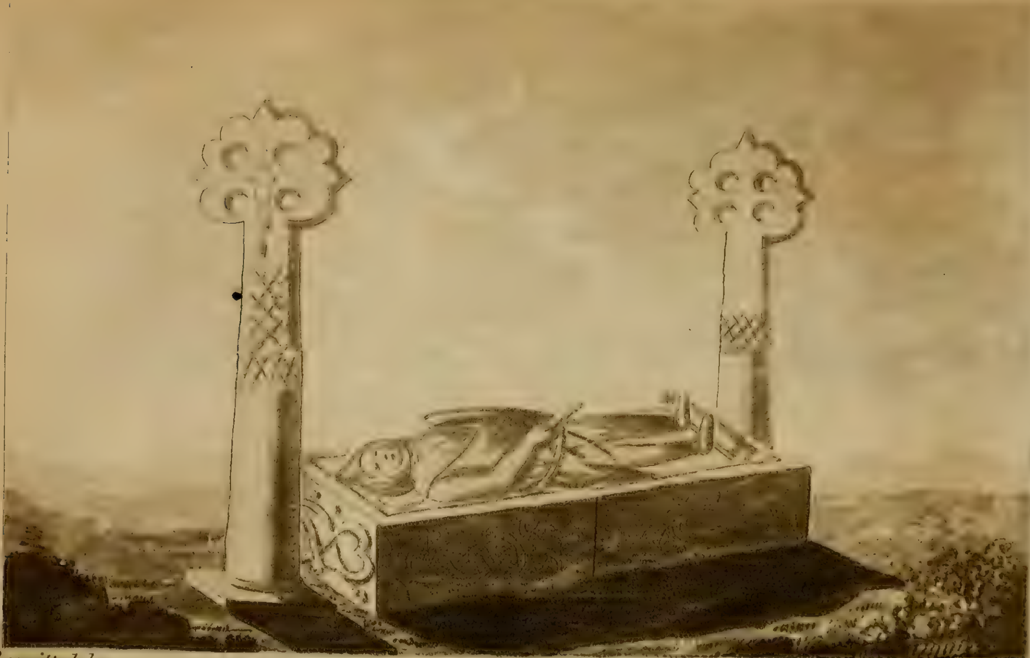
Parapet at Carlisle.

Nithsdale Pillar.

Giants Thumb.

T Barritt del. P. M. Morland sculp.

Pl. VIII



T Barritt del. P. M. Morland sculp.

Monument in Penrith Church Yard supposed in its original state.

has now loſt its flowers, or branches. I make uſe of theſe terms, as implying a remarkable diſtinction from the common ſimple Greek or Latin croſs, which is only compoſed of two croſs beams; the latter with a long ſhaft or pillar, the former with the pillar and arms always of equal length.

In this circumſtance, I muſt now call in the aſſiſtance of heraldry. Having, ſome little time before I ſaw the Penrith pillars, been at Carliſle, and examined the ſtructure of the cathedral, I could not help remarking, that one part of the parapet was crowned in a long range, with what is called in heraldry the Croſs Patonce. The ſweeps or flowerings uniting their extremities with each other, formed a rich embattlement to that ancient ſtructure: this I conjecture to be the part ſaid to be renewed in the time of King Edward the Third; theſe croſſes having their flowerings much curved like thoſe repreſented in the plate, which exhibits to the eye, in each croſs, four piercings: ſimilar portions I found yet remaining upon the pillars at Penrith; and that which ſtands by itſelf, in the ſame church yard, called the Giants Thumb, has ſtill the two lower holes in it, which do not appear in any other croſs in arms. An artiſt, with the aſſiſtance of his pencil, may very eaſily convince any one, how and where ſuch appropriate parts are wanting, as the ſegments of theſe

piercings or circles are plainly viſible, not only upon the pillars at Penrith, but upon that at Nithsdale, mentioned by Captain Riddell. Theſe concurring circumſtances incline me to believe, that the Penrith pillars with that at Nithsdale, are about the date of the fourteenth century; and, from ſimilarity in the ſtyle of execution, there is great probability of their having been executed by the ſame hand, and perhaps very near the ſame time with the repairing of Carliſle Cathedral.

The Nithsdale pillar I have here given in black, and the parts which I judge are wanting, in ſhade, that an opinion may be formed of the propriety of the above conjecture.

The Scotch pillars are deſcribed and engraved in Pennant's Tour; the author of which ſuppoſes them to have been Chriſtian, from the croſſes, though of varied forms, being carved upon them on one ſide, with many fanciful figures on the other. That at Forres is ſuppoſed to be in memory of the final retreat of the Danes; another in memory of the victory of Loncarthy, where the peaſant Hay and his two Sons put a ſtop to the panic of the Scottiſh army, and animated his countrymen to renew the fight.

Although the above are decorated, beſides the croſs, with men, horſes, dogs, and groteſque animals,

mals, which are fuppofed to allude to the above, or to fome other material circumftance relative to Scottifh hiftory, I cannot at prefent be brought to believe any of them to have been erected at the time when any Norwegian, Danifh, or Icelandifh invafion took place in Scotland: the workmanfhip befpeaks the execution of a later period. The knots, foliage, and grotefque imagery, in a great degree, correfpond with the embellifhments of the Penrith and Nithsdale pillars; and I judge them to be nearly of the fame date, of the fourteenth century. When this ftyle was firft introduced, I cannot fay with certainty; but I have frequently feen it exhibited in old houfes, the fcreens of burying chapels in churches, and ornaments in books of fo low a date as the fixteenth century.

There is a crofs remaining on the fpot where the battle of Hedgley Moor, in Northumberland, was fought, in the reign of King Henry the Sixth. The fhaft is entire, and is filled with the bearings of the Percy family, and their alliances; the capital at prefent has the form of a fleur de lis, having perhaps been broken, like the croffes at Penrith. This proves, that croffes were fometimes erected as military monuments. The broken capital of another crofs, with fome remains of fculpture, lies alfo in the Park oppofite to Alnwick Caftle, on the fpot where Malcolm Canmore, King of Scotland, is faid

to

to have been ſlain while he was beſieging that fortreſs. This capital at preſent has the form of a fleur de lis; but as the moſt ornamented croſſes, whether devotional, or family monuments, which remain perfect in the Weſtern Iſles of Scotland, have the croſs incloſed in a quatrefoil,* it is eaſy to conceive how this figure might be produced, by breaking the top and outer limbs of the circles.†

Meteorological

* See Pennant's Voyage to the Weſtern Iſles.

† A croſs formerly ſtood near Wigan, to which the following ſtory relates. Mabel (daughter and co-heir of Hugh Norris, Lord of Sutton, Raynhill, Whiſton, Haigh, Blackrod and Leigh, and wife to Sir William Bradſhaw, of Haigh, in the neighbourhood of Wigan) during the ten years abſence of her huſband, who was reported to be ſlain in the Holy War, married Sir Oſmund Neville, a Welſh Knight. Sir William returned, and aſked alms at Leigh, in the habit of a Palmer. Mabel, ſtruck with this reſemblance of her former huſband, fell a weeping, for which ſhe was ſeverely reproved by Sir Oſmund. Sir William then made himſelf known to his tenants; and Sir Oſmund, on receiving the intelligence, fled towards Wales; but, near to Newton Park, in Lancaſhire, Sir William overtook, and ſlew him. Mabel was enjoined by her confeſſor to do pennance whilſt ſhe lived, by going once every week barefoot and barelegged from Haigh to the above mentioned croſs near Wigan, which was called Mab's Croſs from the above occaſion.

The far-worn effigies of Sir William and Lady Mabel now remain in the chancel of Wigan church. He with his hand upon his ſword, and a ſhield charged with two bends upon his left arm; ſhe is in a long robe, and veiled, with her hands elevated, as at prayer.

METEOROLOGICAL OBSERVATIONS, *collected and arranged by* THOMAS GARNETT, *M. D. Phyſician at Harrogate: Member of the Royal Medical, Royal Phyſical, and Natural Hiſtory, Societies of Edinburgh; of the Literary and Philoſophical Society of Mancheſter; of the Medical Society of London; of the Royal Iriſh Academy, &c. Communicated by Dr.* PERCIVAL.

READ, MARCH 27, 1795.

IT is properly obſerved by a late writer, that there is ſcarce any ſubject in which mankind feel themſelves more intereſted, than in the ſtate of the weather; that is, in the temperature of the air, the influences of wind, rain, &c.* It forms a principal topic of converſation. By the weather the traveller endeavours to regulate his journies, and the farmer his operations; by it plenty and famine are diſpenſed, and millions are furniſhed with the neceſſaries of life. It is intimately connected with the health of the human body, with every part of natural hiſtory, and particularly with agriculture. On account of the extenſive nature of the ſubject, meteorology has long engaged the attention of philoſophers; and many ingenious and plauſible conjectures on the

* Adams's Lectures on natural philoſophy, vol. 4.

the nature of rain, and other meteors, have been given to the public; but the facts of which we are at preſent poſſeſſed, are too few in number, and have been made at places too remote from each other, either to refute or confirm the theories in queſtion.

In the firſt part of this volume is given an account of a number of meteorological obſervations made on the weſtern coaſt of this iſland. Since the publication of that memoir, I have received journals from different parts of the kingdom, and have prevailed on ſeveral philoſophical friends, in various counties, to keep regiſters of the barometer, thermometer, rain, wind, &c. By theſe means I hope we ſhall, in time, ſupply the deficiency of obſervation, and enable the philoſopher to correct his theory by facts.—It is in the power of the Society greatly to promote this undertaking; and it would contribute greatly to the attainment of the object, if they would furniſh intelligent perſons in different parts with proper inſtruments, on condition of their tranſmitting annually an account of their obſervations: and it might perhaps be right to ſtimulate to ſuch exertions, by conferring an honorary premium on thoſe who have made accurate obſervations for a certain number of years.

A publication has lately appeared called the Meteorologiſt's Aſſiſtant in keeping a diary of the

the weather, which will be of great uſe to thoſe who have not been accuſtomed to make ſuch obſervations, and will ſave much labour to thoſe who have. It contains ruled columns for a regiſter of the barometer, thermometer, hygrometer, and wind, at three periods in every day, and the quantity of rain falling each day, with columns for particular and general obſervations. Perhaps one ſtill more convenient might be drawn up, and printed at the expence of the ſociety.

The ſubject of Meteorology is treated in a very philoſophical and ſatisfactory manner by Dr. Darwin, in the firſt volume of his Botanic Garden. The theory of the winds there given, bids fair to explain moſt of the meteorological phenomena.—And, I am of opinion, that if regiſters could be kept ſo as to determine at what hour the winds began to change in many parts of the world, ſomething concerning the weather might be learnt: for, (as Dr. Darwin obſerves, in a letter which I lately received from him) the variation of the courſe of the wind ſeems to be the cauſe of, or key to, the other phenomena of froſt or rain; and this, which is the principal circumſtance in atmoſpheric theory, is moſt deficient in experiments.

For the convenience of comparing the different parts of the following obſervations, I have

divided

divided the memoir into different ſections. The firſt contains the different obſervations which have been made on the Barometer. The ſecond contains obſervations and remarks on the Thermometer. In the third is an account of the quantity of rain which has fallen in different parts of the kingdom, with ſome remarks on the imperfections of rain gages, and the methods of remedying them. The fourth ſection contains an account of the different obſervations made on the winds. To theſe I have added, by way of Appendix, the remarks of ſeveral correſpondents, which could not properly be referred to any of the preceding diviſions.

§ I.

§ I.

OBSERVATIONS on the BAROMETER.

OBSERVATIONS on the BAROMETER at Liverpool for twenty-five Years, abſtracted from a a Journal kept by Mr. HUTCHINSON, late Dock-Maſter of that place.

1768.

	Mean Height.	Higheſt.	Loweſt.
January	29,37	29, 8	28, 9
February	29,16	30, 0	28, 6
March	29,76	30, 1	29, 3
April	29,46	30, 0	29, 2
May	29,34	29, 4	29, 3
June	29,56	30, 5	29,35
July	30,26	30,33	29,20
Auguſt	29,86	30,15	29,35
September	29,75	30,17	28,87
October	29,77	30,23	29,20
November	29,61	30,23	28,35
December	29,72	30,33	28,95

1769.

	Mean.	Higheft.	Loweft.
January	30,18	30,30	29,35
February	29,68	30,20	29,25
March	30,03	30,48	29,10
April	29,92	30,35	29,04
May	29,36	30,54	29,15
June	29,95	30,22	29,55
July	29,74	30,33	29,65
Auguft	29,83	30,15	29,62
September	29,85	30,18	29,22
October	30,16	30,52	29,30
November	29,88	30,55	29,25
December	29,97	30,56	28,55

1770.

	Mean.	Higheft.	Loweft.
January	30,44	30,70	29,40
February	29,31	30,57	28,75
March	30,19	30,20	29,40
April	29,83	30,60	29,20
May	29,86	30,30	29,25
June	29,84	30,18	29,58
July	30,02	30,33	29,55
Auguft	30,12	30,35	29,90
September	29,48	30,28	29,43
October	29,76	30,40	29,08
November	29,34	30,15	28,85
December	29,45	30,20	29,10

1771.

	Mean.	Higheſt.	Loweſt.
January	29,81	30,20	29,10
February	30,02	30,50	29,35
March	29,95	30,40	29,35
April	30,09	30,45	29,73
May	29,61	30,23	29,40
June	30,06	30,33	29,48
July	29,86	30,15	29,45
Auguſt	29,72	29,97	29,40
September	29,85	30,30	29,55
October	29,65	30,35	29,20
November	29,99	30,50	29,25
December	29,46	30,25	28,65

1772.

	Mean.	Higheſt.	Loweſt.
January	29,57	30,25	28,75
February	29,40	29,85	28,92
March	29,17	29,92	28,85
April	29,76	30,15	29,20
May	29,47	30,32	29,40
June	29,86	30,20	29,45
July	29,85	30,25	29,20
Auguſt	29,75	30,12	29,20
September	29,67	30,10	29,10
October	29,73	30,15	29,10
November	29,49	30,25	28,60
December	29,83	30,33	29,20

1773.

1773.

	Mean.	Higheſt.	Loweſt.
January	29,66	30,30	28,50
February	29,38	30,50	28,60
March	30,04	30,32	29,55
April	29,78	30,40	28,93
May	29,71	30,35	28,65
June	29,81	30,05	29,45
July	29,91	30,17	29,65
Auguſt	29,59	30,15	29,43
September	29,61	30,00	29,10
October	29,66	30,23	28,85
November	29,53	30,35	28,25
December	29,64	30,15	29,17

1774.

	Mean.	Higheſt.	Loweſt.
January	29,50	30,20	28,72
February	29,64	30,42	28,90
March	29,77	30,28	29,05
April	29,70	30,25	29,20
May	29,97	30,12	29,25
June	29,77	30,17	29,45
July	29,84	30,17	29,48
Auguſt	29,81	30,22	29,35
September	29,36	30,22	28,95
October	30,01	30,43	29,32
November	39,82	30,28	29,15
December	30,01	30,67	29,05

1775.

	Mean.	Higheſt.	Loweſt.
January	29,69	30,12	29,05
February	29,60	30,32	28,65
March	29,40	30,50	29,00
April	30,00	30,40	29,50
May	30,03	30,20	29,80
June	29,86	30,20	29,60
July	29,56	30,10	29,52
Auguſt	29,73	30,00	29,30
September	29,72	30,00	29,35
October	29,76	30,23	28,65
November	29,77	30,33	28,87
December	29,95	30,45	28,57

1776.

	Mean.	Higheſt.	Loweſt.
January	29,73	30,20	29,25
February	29,35	29,95	28,67
March	29,84	30,32	28,87
April	30,15	30,42	29,70
May	30,00	30,43	29,10
June	29,80	30,32	29,50
July	29,79	30,28	29,15
Auguſt	29,75	30,20	29,35
September	29,80	30,40	29,12
October	30,30	30,32	29,40
November	29,81	30,25	28,98
December	29,88	30,37	29,20

1777.

1777.

	Mean.	Higheſt.	Loweſt.
January	29,80	30,35	29,23
February	29,68	30,12	29,15
March	29,74	30,25	28,92
April	29,97	30,42	29,15
May	29,66	30,07	29,17
June	29,85	30,35	29,63
July	29,82	30,38	29,23
Auguſt	29,93	30,40	29,50
September	30,04	30,30	29,60
October	29,73	30,25	28,30
November	29,92	30,43	28,97
December	29,87	30,23	28,93

1778.

	Mean.	Higheſt.	Loweſt.
January	29,67	30,42	28,73
February	29,81	30,35	29,15
March	29,78	30,45	29,02
April	29,79	30,25	29,35
May	30,14	30,25	29,43
June	29,99	30,27	29,57
July	29,89	30,27	29,43
Auguſt	30,41	30,45	29,62
September	29,97	30,40	29,43
October	29,65	30,08	28,98
November	29,63	30,12	29,23
December	29,78	30,73	28,83

1779.

	Mean.	Higheſt.	Loweſt.
January	30,27	30,65	20,72
February	30,17	30,42	29,52
March	30,16	30,60	29,65
April	29,89	30,53	29,40
May	29,91	30,28	29,57
June	29,95	30,25	29,37
July	29,86	30,35	29,25
Auguſt	30,02	30,32	29,72
September	29,83	30,10	29,28
October	29,83	30,30	29,23
November	29,94	30,35	29,15
December	29,64	30,33	28,75

1780.

	Mean.	Higheſt.	Loweſt.
January	29,87	30,40	29,12
February	29,95	30,55	29,05
March	29,82	30,35	29,35
April	29,66	30,25	28,95
May	29,86	30,22	29,20
June	29,94	30,30	29,63
July	30,03	30,30	29,63
Auguſt	30,12	30,22	29,95
September	29,83	30,13	29,53
October	29,75	30,35	29,25
November	29,86	30,48	29,03
December	30,30	30,55	29,83

1781.

1781.

	Mean.	Higheft.	Loweft.
January	29,89	30,68	29,13
February	29,39	30,30	28,80
March	30,19	30,45	29,97
April	29,41	30,22	29,27
May	29,96	30,37	29,65
June	29,74	30,23	29,50
July	29,89	30,32	29,50
Auguft	29,73	30,23	29,23
September	29,78	30,22	29,33
October	30,03	30,33	29,30
November	29,56	30,10	28,85
December	29,39	30,00	29,15

1782.

	Mean.	Higheft.	Loweft,
January	29,65	30,33	28,87
February	29,81	30,33	28,90
March	29,61	30,25	28,90
Apri	29,56	30,32	28,40
May	29,59	30,23	28,95
June	29,93	30,42	29,35
July	29,83	30,20	29,65
Auguft	29,52	29,97	28,95
September	29,81	30,23	29,13
October	29,74	30,18	29,12
November	29,83	30,43	29,17
December	29,94	30,37	29,35

1783

1783.

	Mean.	Higheſt.	Loweſt.
January	29,37	30,28	28,80
February	29,59	30,55	28,30
March	29,66	30,40	28,35
April	30,06	30,47	29,45
May	29,86	30,22	29,55
June	29,79	30,20	29,10
July	29,85	30,25	29,38
Auguſt	29,81	30,18	29,48
September	29,66	30,25	28,98
October	29,78	30,23	29,30
November	29,80	30,32	29,17
December	29,84	30,32	28,95

1784.

	Mean.	Higheſt.	Loweſt,
January	29,72	30,40	29,30
February	29,64	30,40	28,98
March	29,58	30,00	28,93
April	29,64	30,15	28,85
May	29,95	30,32	29,23
June	29,75	30,30	29,30
July	29,83	30,15	29,23
Auguſt	29,90	30,30	29,40
September	29,53	30,23	29,35
October	30,01	30,25	29,45
November	29,72	30,25	29,25
December	29,64	30,13	28,52

1785.

	Mean.	Higheſt.	Loweſt.
January	29,64	30,13	29,03
February	29,36	30,63	28,73
March	30,27	30,35	29,60
April	30,02	30,35	29,30
May	29,81	30,37	29,33
June	30,01	30,30	29,63
July	29,72	30,36	29,23
Auguſt	29,65	30,01	29,20
September	29,20	30,18	28,92
October	29,42	30,33	29,28
November	29,26	30,35	28,58
December	29,63	30,20	29,05

1786.

	Mean.	Higheſt.	Loweſt.
January	29,46	30,15	28,55
February	29,67	30,25	29,02
March	29,61	30,17	29,14
April	29,80	30,35	29,38
May	30,39	30,25	29,20
June	29,81	30,22	29,62
July	29,87	30,27	29,20
Auguſt	29,68	30,15	29,12
September	29,28	30,23	28,55
October	29,55	30,33	28,45
November	29,68	30,18	28,90
December	29,73	30,33	28,60

1787.

1787.

	Mean.	Higheſt.	Loweſt.
January	30,01	30,47	29,40
February	29,31	30,23	28,35
March	29,58	30,33	28,85
April	29,86	30,33	29,05
May	29,75	30,22	28,82
June	29,73	30,02	29,35
July	29,66	30,25	29,32
Auguſt	29,50	29,97	28,92
September	29,55	30,05	28,55
October	29,24	29,70	28,72
November	29,33	29,93	28,70
December	29,82	29,95	28,50

1788.

	Mean.	Higheſt.	Loweſt.
January	29,55	30,20	28,30
February	29,18	29,83	28,30
March	29,57	29,70	28,93
April	29,61	30,03	28,85
May	29,61	29,95	29,22
June	29,56	29,87	29,13
July	29,47	29,80	29,18
Auguſt	29,48	30,03	28,90
September	29,40	29,75	29,00
October	29,73	30,25	29,25
November	29,65	29,95	29,20
December	29,57	29,85	29,25

1789.

	Mean.	Higheſt.	Loweſt.
January	29,27	30,33	28,50
February	29,22	29,78	28,25
March	29,48	29,95	28,60
April	29,44	29,87	28,80
May	29,54	29,95	29,30
June	29,54	29,95	29,10
July	29,50	29,78	29,30
Auguſt	29,74	30,05	29,42
September	29,54	30,03	29,15
October	29,32	30,00	28,55
November	29,37	30,12	28,50
December	29,45	30,25	28,70

1790.

	Mean.	Higheſt.	Loweſt.
January	29,76	30,20	28,95
February	29,31	30,30	29,30
March	30,01	30,45	29,55
April	29,74	30,15	29,35
May	29,89	30,30	29,30
June	29,70	30,55	29,40
July	29,81	30,20	29,45
Auguſt	29,90	30,15	29,60
September	29,98	30,50	29,40
October	29,87	30,40	29,50
November	29,77	30,35	29,10
December	29,78	30,35	28,95

1791.

	Mean.	Higheft.	Loweft.
January	29,39	30,30	28,35
February	29,96	30,50	29,10
March	30,16	30,65	28,90
April	29,75	30,10	29,10
May	30,00	30,40	29,50
June	29,95	30,30	29,68
July	29,79	30,25	29,35
Auguft	29,99	30,55	29,08
September	30,09	30,35	29,45
October	29,61	30,50	28,70
November	29,68	30,95	28,85
December	29,58	30,20	29,05

1792.

	Mean.	Higheft.	Loweft.
January	29,63	30,35	28,95
February	29,96	30,50	29,55
March	29,69	30,45	29,05
April	29,57	30,30	29,30
May	29,90	30,35	29,10
June	29,91	30,40	29,30
July	29,83	30,10	29,55
Auguft	29,90	30,30	29,20
September	29,71	30,25	29,10
October	29,75	30,45	29,15
November	29,95	30,35	29,15
December	29,83	30,25	29,10

Mean

Mean annual Height and Range of the Barometer, in each of the preceding Years.

Years.	Annual Mean.	Higheft.	Loweft.	Range.	Years.	Annual Mean.	Higheft.	Loweft.	Range.
1768	29,64	30,33	28,06	2,27	1781	29,74	30,68	28,80	1,88
1769	29,87	30,54	28,55	1,99	1782	29,73	30,43	28,40	2,03
1770	29,80	30,70	28,75	1,95	1783	29,75	30,55	28,30	2,25
1771	29,83	30,50	28,65	1,85	1784	29,74	30,40	28,52	1,88
1772	29,61	30,33	28,60	1,73	1785	29,66	30,63	28,58	2,05
1773	29,69	30,50	28,25	2,25	1786	29,71	30,35	28,45	1,90
1774	29,80	30,43	28,72	1,71	1787	29,61	30,47	28,35	2,12
1775	29,74	30,50	28,57	1,93	1788	29,53	30,25	28,30	2,05
1776	29,85	30,43	28,67	1,76	1789	29,45	30,33	28,25	2,08
1777	29,83	30,43	28,30	2,13	1790	29,79	30,55	28,95	1,60
1778	29,87	30,73	28,73	2,00	1791	29,82	30,95	28,35	2,60
1779	29,95	30,65	28,75	1,90	1792	29,80	50,50	28,95	1,55
1780	29,91	30,55	28,95	1,60					

Hence it appears that the mean Height of the Barometer at Liverpool, deduced from an average of twenty-five years, is 29,74 inches: the greateft height, during that period, 30,95, the leaft 28,06 : the greateft range 2,89 ; and the annual average range 1,96.

Mean height of the Barometer at Liverpool in each month, deduced from an average of twenty-five years.

January	29,71	May	29,80	September	29,69
February	29,58	June	29,82	October	29,71
March	29,80	July	29,82	November	29,64
April	29,78	Auguſt	29,81	December	29,64

It is evident from this ſtatement, that the mean height of the barometer is greater during the months of May, June, July, and Auguſt, than in any other four months. And this does not depend upon the expanſion of the mercury by heat, independent of its weight: for the difference in the expanſion of the mercury from this cauſe, between the greateſt cold of winter and heat of ſummer, never exceeds ,03 of an inch.

Obſervations on the Barometer at Dover, extracted from a Journal kept by Mr. T. MANTELL, *Surgeon at Dover.*

The obſervations commence in October 1789.

1789.	Mean.	Higheſt.	Loweſt.
October	29,61	30,21	28,74
November	29,64	30,42	28,60
December	29,81	30,48	29,10

1790.

1790.

	Mean.	Higheſt.	Loweſt.
January	30,02	30,31	29,12
February	30,21	30,49	29,67
March	30,12	30,48	29,20
April	29,63	30,16	29,16
May	29,76	30,10	29,30
June	29,93	30,22	29,29
July	29,98	30,21	29,41
Auguſt	30,16	30,20	29,71
September	30,09	30,42	29,48
October	30,00	30,40	29,60
November	29,87	30,32	29,11
December	29,97	30,38	29,10

1791.

	Mean.	Higheſt.	Loweſt.
January	29,98	30,42	28,48
February	30,00	30,42	29,15
March	30,05	30,95	28,97
April	29,87	30,12	29,11
May	30,12	30,39	29,68
June	30,02	30,32	29,41
July	30,05	30,29	29,50
Auguſt	30,20	30,58	29,71
September	30,21	30,39	29,50
October	29,82	30,46	29,00
November	30,00	30,38	28,64
December	29,60	30,43	28,99

1792.

1792.

	Mean.	Higheft.	Loweft.
January	29,65	30,46	29,10
February	30,00	30,42	29,42
March	29,80	30,38	29,10
April	30,03	30,40	29,11
May	30,08	30,36	29,39
June	29,97	30,33	29,36
July	29,90	30,24	29,51
Auguft	30,01	30,16	29,30
September	29,76	30,41	29,60
October	29,77	30,27	29,21
November	29,91	30,41	29,38
December	29,10	30,25	29,60

1793.

	Mean.	Higheft.	Loweft.
January	29,92	30,45	29,10
February	29,70	30,17	29,18
March	29,82	30,11	29,29
April	29,90	30,30	29,28
May	30,08	30,30	29,35
June	30,18	30,24	29,72
July	30,18	30,40	29,73
Auguft	30,44	30,90	29,40
September*	30,29	30,46	29,50

* The obfervations to the end of the year are not come to hand,

Mean annual height and range of the Barometer in each of the preceding years.

	Annual mean.	Higheft.	Loweft.	Range.
1789	29,68	30,48	28,60	1,88
1790	29,97	30,49	29,10	1,49
1791	29,99	30,95	28,48	2,47
1792	29,83	30,46	29,10	1,36
1793	30,05	30,90	29,10	1,80

Hence the mean height of the Barometer at Dover, on an average of five years, is 29,90 inches: the greateft height during that period 30,95; the leaft 28,48: the greateft range 2,47; and the mean annual range 1,80.

Obfervations

Obſervations on the Barometer at Middlewich, *in Cheſhire; from a Journal kept by* S. Vernon, Esq. *at the requeſt of the late* Dr. Fothergill: *communicated to* Dr. Percival. In this Journal, Mr. Vernon has only given the greateſt and leaſt heights of the Barometer in each Month with the range, there is no way therefore of deducing the monthly mean.

	1768			1769			1770			1771			1772		
	Higheſt.	Loweſt.	Range.	Higheſt.	Loweſt.	Range.	Higheſt.	Loweſt	Range.	Higheſt.	Loweſt.	Range.	Higheſt.	Loweſt.	Range.
Jan.	30,15	29.39	0,85	30,10	29,30	0,80	30,60	29,24	1,36	30,12	29,05	1,07	30,36	29.36	1,00
Feb.	30,30	28,90	1,40	30,11	29,10	1,01	30,44	28,71	1,73	30,35	29,24	0,11	29,89	28,93	0.96
Mar.	30,45	29,65	0,80	30,42	28,98	1,44	29,98	29,14	0,84	30,18	29,24	0,94	30,00	28,89	1,11
Apr.	30,31	29,49	0,82	30,24	28,92	1,32	30,35	29,05	1,30	30,29	29,50	0,79	30,10	29.53	0.57
May	30,23	29,20	1,03	30,50	29,30	1,20	30,16	29,21	0,95	30,16	29,33	0,83	30.30	29,40	0,90
Jun.	30,14	29,26	0,88	30,17	29,45	0,72	30,04	29,45	0,59	30,30	29,36	0,94	30,33	29.50	0,83
Jul.	29,97	29,25	0,72	30,26	29,64	0,62	30,25	29,60	0,65	30,19	29,45	0,84	30,39	29,59	0,80
Aug.	30,09	29,30	0,79	30,10	29,52	0,58	Not obſerved.			30,10	29,48	0,62	30,27	29,27	1,00
Sep.	31,00	28,79	2,21	30,35	29,70	0,65	30,20	29,44	0,96	30,33	29,64	0,69	30,19	29,16	1,03
Oct.	30,14	29,14	1,00	30,45	39,44	1,01	30,35	29,00	1,35	30,50	29,30	1,20	30,27	29,16	1,11
Nov.	30,20	28,00	2,20	30,32	29,43	0,89	30,09	28,92	1,17	30,62	28.86	1,76	30.35	29.99	1.36
Dec.	30,32	28,92	1,40	30,36	28,41	1,95	30.06	29,06	1,00	30,36	28,88	1,48	30,40	29.28	1.12

Mean of the extremes, or mean ranges in each of the preceding years.

	Higheſt.	Loweſt.	Range.
1768	31,00	28,00	3,00
1769	30,50	28,92	1,58
1770	30,60	28,71	1,89
1771	30,62	28,86	1,76
1772	30,40	28,89	1,51

The greateſt height of the Barometer, during the preceding years at Middlewich, was 31,00; the leaſt 28,00; the greateſt range 3,00; and the mean annual range 1,94.

The latitude of Middlewich is 53°. 12°.

Obſervations on the Barometer at Kendal, by Mr. J. Gough. *Continued from p.* 258.

Mean monthly heights of the Barometer.

	1792	1793	1794
January		29,902	29,871
February		29,585	29,621
March		29,756	29,800
April		29,852	29,772
May		29,014	29,901
June		29,844	29,995
July		29,934	29,917
Auguſt	29,875	29,795	29,833
September	29,644	29,895	29,805
October	29,709	29,807	29,667
November	29,876	29,727	29,505
December	29,682	29,615	29,329

Mean

Mean annual height of the Barometer for the preceding years.

1792	1793	1794
29,759	29,810	29,793

Observations on the Barometer at Dumfries, by MR. ALEX. COPLAND. Continued from p. 272.

1793	Monthly Mean for 1793.	Above the Medium.	Below the Medium.	Medium of each Month for six Years.
January	29,8062	0,3189		29,4873
February	29,4992		0,1648	29,6640
March	29,7079	0,0303		29,6776
April	29,8232	0,1299		29,6933
May	29,8989	0,1077		29,7912
June	29,7885		0,0281	29,8166
July	29,8429	0,0358		29,8071
August	29,7311		0,1192	29,8503
September	22,8922	0,1119		29,7803
October	29,7445	0,0629		29,6816
November	29,7175	0,0956		29,6219
December	29,5713	0,0148		29,5565

The annual mean for the six preceding years is 29,7019. The annual mean for 1793, is 29,7518, which is 0,0499 above the medium.

Mean

Mean height of the Barometer at Dumfries in each feafon of the year 1793, compared with the mean of the fame feafons for the laft fix years.

1793.	Medium in 1793.	Above the Medium.	Below the Medium.	Medium for fix preceding years.
Spring	29,6768		0,0015	29,6783
Summer	29,8434	0,0385		29,8049
Autumn	29,7893	0,0186		29,7707
The three winter months	29,6983	0,1431		29,5552

Barometer higheft 30,45 ; loweft 28,57 ; range 1,88.

Obfervations on the Barometer at Kefwick, for 1793, *by* Mr. Peter Crosthwaite. Continued from Mr. Dalton's Meteorological Obfervations and Effays, page 15.

1793.	Mean.	Higheft.	Loweft.	Range.
January	29,66	30,28	28,52	1,76
February	29,31	29,77	28,64	1,13
March	29,48	30,03	28,82	1,21
April	29,60	30,10	28,97	1,13
May	29,76	30,08	28,68	1,40
June	29,60	29,98	29,37	0,61
July	29,68	29,93	29,14	0,79
Auguft	29,54	29,85	29,13	0,72
September	29,65	30,08	29,12	0,96
October	29,56	30,14	28,82	1,32
November	29,48	30,17	28,65	1,52
December	29,34	30,15	28,33	1,82

The

The greateft height of the barometer at Kefwick during the year 1793 was 30,28; the leaft height 28,33; the mean height 29,55; the greateft range 1,95; the mean monthly range 1,11. According to Mr. Dalton, (Meteorological Effays, p. 16) the mean annual height is 29,79, confequently the mean height for this year is ,24 below the medium.

Obfervations on the Barometer at York, abftracted from a Journal kept by the late Dr. White, *and communicated by* Dr. Fowler, *of York.*

	Mean height of barometer in 1771.	Ditto in 1772.	Ditto in 1773.	1774.			
				Mean.	Higheft.	Loweft.	Range.
January	29,40	29,50	29,37	29,32	30,12	28,60	1,52
February	29,87	29,45	29,56	29,65	30,50	28,80	1,70
March	29,72	29,47	30,05	29,70	30,40	29,00	1,40
April	29,95	29,75	29,70	29,75	30,40	29,10	1,30
May	29,70	29,90	29,97	29,75	30,20	29,30	0,90
June	29,81	29,87	29,83	29,82	30,25	29,40	0,88
July	29,81	29,81	29,95	29,92	30,27	29,60	0,67
Auguft	29,67	29,71	29,82	29,77	30,30	29,25	1,05
September	29,97	29,50	29,50	29,65	30,30	29,00	1,30
October	29,62	29,67	29,62	29,90	30,51	29,30	1,21
November	29,92	29,57	29,32	29,62	20,25	29,10	1,15
December	29,51	29,80	29,62	29,97	30,75	29,20	1,55

The

The reafon why the greateft and leaft heights are only given in the year 1774, is becaufe I received only an abftract of Dr. White's Journal for the preceding years containing the mean heights, but the complete Journal for the year 1774.

Mean height of the Barometer in each of the preceding years, with the annual Range in 1774.

	Mean height.	Higheft.	Loweft.	Range.
1771	29,74			
1772	29,66			
1773	29,69			
1774	29,73	30,45	28,60	2,15

It appears from hence, that the mean annual height of the Barometer at York, on an average of four years, is 29,70. The greateft height during the year 1774, was 30,75; the leaft 28,60: the greateft range 2,15; and the mean range 1,21.

Obfervations on the Barometer at Harrogate.

1794	Greateft height.	Leaft height.	Mean.
June	29,80	29,21	29,38
July	29,85	28,90	29,25
Auguft	29,72	28,85	29,01
September	29,75	28,60	29,32
October	29,81	28,45	29,21
November	29,65	28,60	29,15
December	29,85	28,95	29,24

Mean

Mean height of the Barometer at different places, with the number of years for which the mean was deduced.

Liverpool.		Dover.		Kendal.		Dumfries.		Kefwick.		York.	
Years.	Mean height.	Years.	Mean height.	Years.	Mean height.	Years.	Mean height.	Years.	Mean height.	Years.	Mean height.
25	29,74	4	29,90	8	29,78			5	29,72	4	29,70

If thefe numbers were deduced from obfervations for a great number of years, they would afford a means of afcertaining the refpective heights of the barometer at each place above the level of the fea. None of the above however can be depended upon, excepting thofe at Liverpool, the others having been made far too fhort a fpace of time to give the true means.

I fhall conclude thefe obfervations on the Barometer, with a table of the fpace moved through by the mercury in the barometer at Kendal, for fix years, which was communicated to me by Mr. Gough. He obferves that, "the barometer

" has been long valued for indicating the " changes of the weather; and philoſophers " have not (as far as he knows) made any " uſe of it, beſides remarking the mean and " extreme heights of the mercury; circum- " ſtances which are much influenced by local " elevation: but tables expreſſing the ſpaces " moved through by this fluid in the tube, " for the ſeveral months of a ſeries of years, " promiſe to be of more ſervice to ſcience. " For, by comparing part of that which follows, " with one made from the obſervations of the " Royal Society, I find (ſays he) that the " motion in queſtion, as well as the rain, is " much leſs at London than at Kendal. I do " not pretend to account for this curious cir- " cumſtance. Meteorology is too near a ſtate " of infancy to admit of complete explanations. " Facts not theories are what we want; and if " they be ever obtained, the joint labours of many " obſervers muſt ſupply them. The tables here " recommended are liable to ſome imperfec- " tions, which need not be pointed out to thoſe " who underſtand the ſtructure of the inſtru- " ment. The inaccuracies are conſiderably " diminiſhed in mine, by the baſon and tube " of the barometer being wide; and by taking " the obſervations three times a day, which is " alſo done with the thermometer."

Space

Space moved through by the Mercury in the Barometer at Kendal for fix years.

	1788	1789	1790	1791	1792	1793	Mean
January	10,75	10,76	8,53	13,84	8,32	7,28	9,946
February	7,31	10,63	5,85	9,01	7,01	9,30	8,185
March	7,12	6,98	4,03	6,74	9,63	8,44	7,156
April	6,62	7,49	4,44	5,64	5,77	5,88	5,973
May	4,62	6,20	4,56	6,18	6,89	5,59	5,673
June	3,19	4,88	4,94	2,48	5,03	4,32	4,223
July	4,81	4,18	6,46	5,70	5,25	4,39	5,131
Auguft	4,25	3,87	4,65	5,54	5,50	6,42	5,036
September	5,62	5,41	6,43	5,89	8,19	5,94	6,246
October	5,25	7,13	6,30	7,48	5,92	6,50	6,430
November	6,38	7,14	7,88	7,68	7,74	5,77	7,098
December	5,71	9,76	12,93	11,23	13,41	7,42	10,076
Total	71,63	84,43	77,00	87,41	88,66	77,95	81,173

Captain Burton, of Ripon, lately fhewed me an improvement which he had made in the index of the barometer, which may be of ufe to obfervers, and particularly in the menfuration of heights by means of that inftrument.

(Pl. IX. Fig. 1.) *A* is a micrometer-fcrew, containing two hundred threads in an inch :

 the

the bottom of it is faſtened to the index *C*, which it moves up and down the $\frac{1}{200}$ part of an inch at every revolution. Behind *B* is a wheel, containing two hundred teeth, which are moved by the threads of the ſcrew. This wheel carries the index *B*, which moves round the graduated circle divided into two hundred parts, while the ſcrew moves one inch.—The ſcrew *A* is moved by the hand, till the index *C* be exactly on a level with the ſurface of the mercury; and the index *B* ſhews the height of the fluid.

§ II.

OBSERVATIONS ON THE THERMOMETER.

Obſervations on the Thermometer at Liverpool, extracted from MR. HUTCHINSON'S *Journal.*

Theſe obſervations on the Thermometer were made at twelve o'clock at noon. The Thermometer was raiſed about forty feet above high-water-mark. It was placed under a table (to prevent the rain having any effect upon it) facing the North, in an open obſervatory at the top of houſe. The houſe was conſiderably elevated above the adjoining ones; and the obſervatory was as much expoſed to the open air as poſſible.

1768

	1768.			1769.			1770.			1771.			1772.		
	Mean.	Higheft	Loweft.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.
January	40	52	29	48	53	42	46	57	37	42	56	41	44	52	40
February	50	58	43	48	53	44	49	57	41	48	56	40	44	53	38
March	51	56	47	52	57	45	46	53	42	48	56	43	49	55	41
April	56	59	51	55	64	47	51	57	48	53	59	47	54	59	48
May	61	68	50	59	66	54	*	†		61	67	54	55	63	50
June	64	71	55	61	62	60				64	74	57	66	72	55
July	66	70	63	68	78	60				65	73	60	67	75	64
Auguft	65	70	61	64	70	61				63	69	60	66	71	62
September	60	65	58	62	69	56				61	67	58	62	67	57
October	58	63	55	56	62	50				58	64	54	63	65	56
November	51	55	47	55	57	44				52	58	48	52	57	48
December	46	57	40	48	55	44				51	55	47	49	55	40

* Obfervations on the Thermometer only for the firft fix days of this month.

† No more obfervations on the thermometer this year.

	1773.			1774.			1775.			1776.			1777.		
	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.
January	50	57	46	44	49	40	50	57	44	42	52	34	42	55	34
February	44	56	42	48	54	43	53	58	50	48	52	34	39	53	32
March	53	61	48	53	60	48	53	57	47	53	62	48	50	68	34
April	55	62	50	56	64	52	60	71	54	58	62	54	51	60	42
May	57	67	50	59	66	52	61	67	54	59	67	52	57	64	50
June	63	70	59	63	66	59	69	76	62	61	69	59	61	70	52
July	65	73	60	64	68	61	67	72	62	66	70	64	64	78	57
Auguft	69	76	62	67	72	64	66	71	63	64	73	61	66	79	56
September	69	68	56	62	68	59	64	72	60	63	70	60	64	77	54
October	58	64	55	61	67	54	58	67	50	59	65	56	55	66	46
November	51	58	45	52	63	44	51	57	46	53	62	43	48	58	40
December	50	55	46	49	55	39	52	62	45	51	60	44	39	53	31

	1778.			1779.			1780.			1781.			1782.		
	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.
January	39	48	31	41	52	32	34	44	24	36	52	24	45	56	34
February	41	50	34	53	66	44	39	50	32	45	50	40	39	52	32
March	45	56	36	54	66	44	50	59	44	54	60	40	42	50	34
April	52	74	41	56	70	50	47	58	44	56	68	48	43	54	34
May	61	72	52	61	78	48	59	80	50	60	84	50	50	64	44
June	66	77	52	66	76	58	61	84	55	66	82	54	61	78	44
July	66	78	58	73	88	64	68	78	58	69	83	56	63	78	54
Auguſt	69	81	60	73	84	64	75	82	66	69	80	62	59	66	50
September	60	74	49	63	74	57	67	78	60	62	76	54	60	72	48
Oćtober	52	63	40	56	64	50	53	62	44	57	64	44	48	54	40
November	47	56	38	51	57	40	43	54	32	48	58	40	39	58	30
December	46	55	38	39	53	26	39	46	26	44	54	34	39	58	30

	1783.			1784.			1783.			1786.			1787.		
	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.
January	40	48	28	32	44	26	37	48	28	39	50	22	39	52	30
February	42	50	32	35	48	32	34	44	26	37	48	30	46	50	34
March	42	52	32	40	48	32	37	46	30	39	53	28	46	56	38
April	56	68	44	45	56	34	53	68	38	51	62	38	47	56	40
May	54	66	44	59	76	48	57	66	48	55	68	44	55	60	40
June	61	72	52	57	68	52	66	86	50	66	80	54	56	66	52
July	66	80	58	62	74	54	65	76	54	62	70	50	57	70	48
Auguft	64	76	52	60	72	54	58	70	50	62	72	54	57	74	52
September	58	66	52	62	76	52	57	70	50	55	65	48	56	66	50
October	52	62	42	49	58	44	51	62	36	48	62	36	51	60	42
November	44	52	32	42	50	34	44	54	38	39	48	32	45	58	35
December	34	48	24	32	46	26	36	46	30	40	48	28	41	57	31

	1788.			1789.			1790.			1791.			1792.		
	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.
January	42	50	36	38	54	22	42	52	35	42	53	36	30	50	28
February	41	48	31	44	52	39	48	54	40	44	54	36	44	54	33
March	41	59	30	42	47	33	48	57	41	49	58	39	47	55	37
April	52	70	44	50	58	43	48	55	42	53	67	43	54	68	43
May	65	81	43	58	68	45	54	66	46	56	76	43	55	61	47
June	66	85	59	59	76	52	61	75	50	64	86	54	60	71	53
July	64	71	57	63	73	53	62	70	53	61	77	54	63	70	57
Auguſt	65	74	59	67	78	61	63	72	53	63	73	47	64	78	59
September	61	71	48	60	68	52	55	65	49	61	78	46	57	68	51
October	53	61	45	50	57	41	52	65	45	52	65	47	52	64	43
November	45	57	33	44	50	35	45	54	33	45	54	42	49	59	40
December	33	44	25	46	53	39	42	50	32	38	50	32	45	53	33

Mean annual height and range of the Thermometer in each of the preceding years.

Years.	Mean.	Higheſt.	Loweſt.	Range.	Years.	Mean.	Higheſt.	Loweſt.	Range.	Years.	Mean.	Higheſt.	Loweſt.	Range.
1768	55	71	29	42	1776	56	73	34	39	1785	49	86	26	60
1769	56	78	42	36	1777	53	79	31	48	1786	49	72	22	50
1770	48	57	37	20	1778	53	80	31	49	1787	49	74	30	44
1771	55	74	40	34	1779	57	88	26	62	1788	52	85	25	60
1772	55	75	38	37	1780	52	84	24	60	1789	51	78	22	56
1773	57	76	42	34	1781	55	84	24	60	1790	51	75	32	43
1774	56	72	40	32	1782	49	78	30	48	1791	52	86	32	54
1775	58	76	44	32	1783	51	80	24	60	1792	51	78	28	50
					1784	47	76	26	50					

Hence it appears, that the mean heat at Liverpool at twelve o'clock, deduced from an average of twenty-five years, is 53° of Fahrenheit's Thermometer : the greateſt degree of heat during that period 86 ; the leaſt 22° : the greateſt range 64° ; and the mean annual range 46°.

Mean height of the Thermometer at Liverpool in each month on an average of twenty-five years.

February	44	May	58	Auguſt	65	November	47
March	47	June	63	September	61	December	43
April	52	July	65	October	54	January	41
Mean heat of the Spring	48	Mean heat of Summer	62	Mean heat of Autumn	60	Mean heat of Winter.	44

Observations on the Thermometer at Dover, abstracted from Mr. MANTELL'S *Journal.*

	1789.			1790.			1791			1792.			1793.		
	Mean.	Highest	Lowest.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.
January				36	45	28	36	47	26	32	44	17	32	40	25
February				39	49	29	34	43	27	33	44	16	36	41	30
March				39	48	34	37	46	26	37	49	22	37	44	37
April				38	50	32	44	54	37	44	56	34	39	47	30
May				50	60	42	46	53	34	45	54	37	45	54	40
June				55	86	46	53	86	47	51	71	45	51	70	42
July				56	69	49	55	67	48	56	66	50	61	77	50
August				57	74	47	58	72	47	61	78	51	62	76	53
September				50	61	44	55	66	44	50	63	40	51	66	41
October	45	57	33	48	60	35	45	55	35	46	54	37			
November	37	47	27	39	50	28	39	44	28	40	49	28			
December	39	46	28	36	50	26	31	43	26	36	47	27			

Mean annual height and range of the Thermometer at Dover for the preceding years.

Years.	Mean.	Higheſt.	Loweſt.	Range.
1789	40	57	27	30
1790	45	86	26	60
1791	44	76	26	50
1792	44	78	16	62
1793	46	77	25	52

From this it would appear, that the mean heat at Dover is 53° : the greateſt degree of heat noticed in the obſervations for the preceding years 86° ; the leaſt 16 : the greateſt range 70° ; and the mean annual range 51° nearly.

The mean here is however lower than the truth, owing to the obſervations of the firſt and laſt years not being complete.

If we take the three complete years, viz. 1790, 1791, and 1792, the means will ſtand thus.

Annual mean 44°.

Annual range 57.

I cannot, however, but ſuſpect that the mean annual heat at Dover, will be found greater than it is given by calculation from theſe obſervations.

The obſervations were taken three times a day, at eight o'clock A. M. at four and ten P. M.

P. M. In all probability, if the middle obfervation had been taken at two o'clock P. M. the mean degree of heat would have been about 48°. or 49°. or, acccording to Mr. Kirwan's Theorem, 50°.

Mean height of the Thermometer in each Month, at Dover.

February	36	May	48	Auguft	59	Nov.	39
March	37	June	52	Septemb.	51	Dec.	35
April	41	July	57	October	46	January	34
Mean heat of the Spring	38	Mean heat of Summer	52	Mean Autumnal heat	52	Mean heat of Winter	36

Mean

Obſervations on the Thermometer at Middlewich. From Mr. Vernon's *Journal.*

The Thermometer was placed in a room facing the North Eaſt, where no fires were kept; and the remarks were made about ten o'clock in the morning.

	1768.				1769.				1770.				1771.				1772.			
	Mean	Higheſt	Loweſt	Range	M.	H.	L.	R.	M.	H.	L.	R.	M.	H.	L.	R.	M.	H.	L.	R.
January	35	46	23	23	36	45	32	13	42	48	30	18	37	50	28	22	35	40	31	9
February	44	52	35	17	40	47	38	9	43	50	34	16	39	50	28	22	37	46	21	25
March	45	50	38	12	47	50	43	7	41	49	36	13	40	49	34	15	44	50	34	16
April	53	58	48	10	53	66	45	21	48	55	43	12	47	52	39	13	50	55	41	14
May	66	74	49	25	60	67	51	16	58	66	44	22	61	67	48	19	56	62	49	13
June	66	74	56	17	63	67	58	9	62	65	56	9	65	76	56	20	68	76	54	22
July	68	74	65	9	70	78	64	14	65	74	57	17	66	75	62	13	69	76	66	10
Auguſt	67	73	62	11	65	70	61	9	Not obſerved				64	69	58	11	66	70	63	7
September	58	65	53	12	60	64	55	9	65	70	59	11	59	64	54	10	60	66	52	14
October	53	60	47	13	51	56	48	8	51	60	40	20	51	60	44	16	56	61	48	13
November	45	49	38	11	45	47	36	11	44	50	34	16	45	52	37	15	47	54	38	16
December	42	48	34	14	42	50	34	16	40	46	31	15	42	49	34	15	42	50	34	16

Mean annual heat, and range of the Thermometer in each of the preceding years.

Years	Mean	Higheft	Loweft	Range
1768	53	74	23	51
1769	53	78	32	46
1770	51	74	30	44
1771	51	76	28	48
1772	52	76	21	55

The mean heat at Middlewich appears from hence, to be 52°. from an average of five years. The greateft heat during that period was 78°. The leaft 21: The greateft range 57; and the mean annual range 49.—It muft be remembered, however, that the Thermometer was not expofed to the open air, but kept in a room facing the North Eaft, in which there was no fire.

Mean height of the Thermometer at Middlewich, in each month, on an average of five years.

February	40	May	60
March	43	June	65
April	50	July	68
Mean heat of the Spring.	44	Mean heat of Summer.	64

Auguft

Auguft	65	November	45
September	60	December	42
October	52	January	37
Mean heat of Autumn.	60	Mean heat of Winter.	41

Observations on the Thermometer at Kendal, by Mr. J. Gough. Continued from p. 258.

	1792.	1793.	1794.
	Mean height of the Thermometer.	Mean heat.	Mean heat.
January		35,03	35,204
February		38,41	42,809
March		37,43	42,540
April		42,31	47,655
May		52,69	51,392
June		55,91	61,511
July		62,43	63,903
Auguft	60,59	57,81	57,215
September	50,57	51,88	52,900
October	46,30	51,34	47,263
November	43,49	41,59	41,020
December	38,35	40,60	38,204

Mr. Gough ſays, that " the obſervations " from which theſe means are deduced, were " taken three times a day. The annual mean " temperature, found in this manner, agrees " very well with the temperature of our beſt " ſprings, which is nearly invariable. Now, " according to Kirwan's eſtimate, the mean " heat of the ocean in latitude 54°, 5' is " nearly 48,8 of Fahrenheit's ſcale; and ſup- " poſing, what is near the truth, the eleva- " tion of the town and its diſtance from the " ocean to be ſixty yards and twenty-five " miles reſpectively, the greateſt correction we " are authorized to make, by the rules laid " down in the fifth Chapter of Mr. Kirwan's " work, reduces it to 48,20. which exceeds " the mean drawn from actual obſervation by " one degree at leaſt: a difference that can " only be attributed to the influence of the " extenſive chain of hills which incumbers this " part of England; and which has, un- " doubtedly, a very ſenſible effect on the tem- " perature, as well as the other properties of " the weather."

Obſervations on the Thermometer at Dumfries, by MR. ALEX. COPLAND, *continued from p. 272.*

1793.	Medium for each month,	Above the medium.	Below the medium.	Medium of each month for ſix years.
January	38,0622	2,2204		35,8418
February	43,4687	2,6732		40,7955
March	41,9241		1,7409	43,6650
April	48,8540		,8677	49,7217
May	57,3750		,5064	57,8814
June	60,5000		2,4007	62,9007
July	68,9820	2,628		66,3540
Auguſt	63,5072		1,9900	65,4972
September	56,9220		1,1030	58,0250
October	55,0312	4,8946		50,1366
November	43,0240	1,1644		41,8596
December	42,3527	4,4231		37,9296
Annual mean.	51,6669	9,3950		50,8840

Medium heat in each Seaſon.

1793.	Medium 1793.	Above the medium.	Below the medium.	Medium for ſix preceding years.
Spring	44,7489	,0215		44,7274
Summer	62,2857		,0926	62,3783
Autumn	58,4868	,6005		57,8863
Winter	41,1463	2,6027		38,5436

Observations on the Thermometer at Keswick, in 1793, *by* MR. PETER CROSTHWAITE. *Continued from p.* 28 *of Mr. Dalton's Observations.*

1793	Mean.	Highest.	Lowest	Range.
January	37	48	23	25
February	41	50	30	20
March	41	50	32	18
April	42	55	26	29
May	50	64	39	25
June	54	63	46	17
July	63	84	51	33
August	57	69	52	17
September	51	63	42	21
October	51	59	33	26
November	41	56	27	29
December	40	50	29	21

Observations on the Thermometer at York, from DR. WHITE'S *Journal.*

	1771	1772	1773	1774		
	Mean Height			Mean.	Highest.	Lowest.
January	36	23	35	27	39	15
February	30	29	29	39	56	23
March	35	37	49	44	58	31
April	40	41	57	54	68	40
May	51	Broken	70	64	85	43
June	53	—	78	68	87	49
July	56	—	81	75	98	52
August	54	—	75	75	96	54
September	52	—	58	62	80	45
October	48	—	47	50	60	41
November	42	45	37	40	48	32
December	38	48	34	30	39	21

Observations

Observations on the Thermometer at York, in the year 1794, *by the* REV. MR. WELLBE.

The obfervations were made at eight o'clock A. M. and P. M.

1793	Mean.	Higheft.	Loweft.
January	34	37	21
February	44	54	37
March	43	54	33
April	49	63	39
May	51	64	40
June	55	69	44
July	60	67	53*
Auguft	58	67	50
September	53	63	43
October	47	59	37
November	42	53	33
December	38	55	27

It would appear, from Dr. White's and Mr. Wellbe's obfervations, that the mean annual heat at York is 49°.

* During the months June and July, owing to Mr. W's abfence, the diary was interrupted.

The

The medium heat of each ſeaſon, deduced from the ſame obſervations, is as follows.

February	35	May	59
March	43	June	63
April	50	July	68
Mean heat of Spring	$42\frac{2}{3}$	Mean heat of Summer	$63\frac{1}{3}$

Auguſt	65	Nov.	40
Septemb.	56	Dec.	35
October	48	January	33
Mean heat of Autumn	$56\frac{1}{3}$	Mean heat of Winter	36

Some Obſervations on the Thermometer at Mancheſter, by MR. GEORGE WALKER.

March 9th. 1786, at 8 A. M. the Thermometer was at - - 16°.

Jan. 28th. 1787,	8 A. M.	- - -	30.
Aug. 7th. ——,	noon	- - - -	74.
March 8th. 1788,	8 A. M.	- - -	19.
May 25th. ——,	4 P. M.	- - -	$78\frac{1}{2}$.
Sept. 11th. 1791,	2 P. M.	- - -	74.

—— In the ſunſhine 130°. The inſtrument, in this inſtance, was placed perpendicularly

dicularly to the ſolar rays, and had a metallic ſcale.

Jan.	12th. 1792, at 8 A. M.	- - -	19.
Aug.	8th. ——, 3 P. M.	- - -	74.
1793.	Loweſt	- - - -	28.
	Higheſt	- - - -	78.

As the preceding obſervations were made, I believe, with common mercurial thermometers, the mean annual heat of each place cannot be determined accurately from them. As the greateſt degree of cold within the twenty-four hours, which occurs about half an hour before ſun-riſe, has ſeldom been obſerved, the mean heat deduced from theſe obſervations, will be ſome degrees higher than the true mean.—The beſt thermometers for obſervations of this nature, are thoſe invented by Mr. Six, which point out the greateſt and leaſt degrees of heat in the obſerver's abſence.

The following account of very great degrees of cold, which were obſerved at Chatham in January 1776, with the height of the barometer and direction of the winds at that time, with ſome other obſervations, was communicated to me by Dr. Percival.

Height

Height of the Thermometer.—Fahrenheit's Scale.																									Thermometer not higher than	Height of the Barometer at two o'clock P. M.	Wind at two o'clock P. M.
	Ante Meridiem.												Post Meridiem.														
Hours	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII			
Sat. 20														28		25		17	9	8½	9	11	14			29,72	NNW.
Friday 26														23		21	20	20	19		18	16½				29,84	E.
Saturday 27								17						17½					15	14	14	14			20	29,81	E.
Sunday 28								14	16					17		15		13	12	11	10	10½	11		18	30,04	E.
Monday 29								7						23				15		8½	10	11	9½		24	29,92	E.
Tuesday 30								10		11		17		19½		19		12	11	7	4½	3½	1	½	21	30,07	E.
Wednes. 31	1	1				0 3½	0 3½	0 3½	0	6	11	17	22	22½	20	14	10	5	3	1	0	0 1	0 1½		23	30,10	Calm
Thur. Feb. 1							4	6	12		25	29		32												29,91	S.

On January 13, 14, 15, there fell fo much fnow, that the great turnpike road between London and Dover, was utterly impaffable even for horfemen, for feveral days. On the 28th. the river Medway (the water of which is falt) was frozen over, from Rochefter bridge to Gillingham. Many hundreds of perfons walked from one fhore to the other: and butts of water were rolled over the ice from the King's dock yard, to the men of war in the harbour. The breath of many was condenfed and frozen to the fheets near their mouths in bed, in chambers, which at every other time would be called warm rooms.—January 29, 30, 31, were clear days, not one cloud was feen. A Thermometer was conftantly expofed to the fun, which at no time was able to raife the mercury higher than one degree above the freezing point; but the greateft part of the day not fo high by many divifions. Two Thermometers (made by Nairne) were ufed in the above obfervations. They are very good ones, being graduated according to the bores of the tubes: they not only correfpond with each other, but alfo with others of the beft fort. Thefe obfervations were made in a garden near the market-place, by Mr. Simmons, furgeon; who, when the thermometer had fallen to four, which was the greateft degree of natural cold he re-

 membered

membered to have obſerved in England, hardly crediting the evidence of his eyes, immediately procured the concurrent teſtimony of two curious and intelligent friends, who were alſo eye witneſſes to the ſtill more aſtoniſhing degrees which ſucceeded.—Where there are blank ſpaces in the table, no obſervations were made. Below nought is ſignified by an o over the figures.

§ III.

OF RAIN.

Obſervations on the quantity of Rain which fell at Liverpool, with the number of wet and variable days in each month, for a period of eighteen years, beginning with the year 1775. *Abſtracted from* Mr. Hutchinson's *Journal.*

When rain is mentioned both in the morning and evening obſervations of Mr. Hutchinſon's Journal, unleſs it is obſerved to be but little, I have called the day wet; and where rain occurs in the morning, or evening obſervation only, unleſs it is obſerved to be heavy, I have called the day variable.—The height of the rain was given in inches and eighths, and fractions of eights, which, for the convenience of comparifon, I have reduced to decimals,

	1775.			1776.		
	Inches of rain.	Wet days.	Variable.	Inches of rain.	Wet days.	Variable.
January	1,1296	6	13	1,5624	9	9
February	2,6250	5	14	4,2500	11	11
March	1,5351	6	10	1,8750	5	13
April	0,5632	2	9	1,0624	5	8
May	0,6891	1	9	1,1874	4	15
June	2,2812	3	11	3,0000	7	13
July	4,9648	9	14	3,8124	7	15
Auguſt	3,3437	9	12	3,5624	11	16
September	3,0000	4	12	5,2186	9	19
October	4,3750	10	15	2,2186	4	9
November	2,8437	9	6	2,9062	9	7
December	2,3281	5	14	2,5312	6	13

	1777.			1778.		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	1,8750	2	12	2,0312	8	10
February	2,2500	8	11	1,0624	4	10
March	2,1250	7	8	1,8436	8	11
April	1,9062	6	8	1,7186	8	12
May	2,8124	6	13	2,4686	5	17
June	2,2500	6	14	4,1250	6	15
July	2,4374	6	9	5,5000	7	13
Auguſt	3,2186	9	11	0,7186	1	8
September	2,2186	5	9	2,0936	2	18
October	4,1250	9	10	5,2500	9	8
November	3,3436	9	12	4,8436	12	11
December	1,6250	5	9	3,9686	12	8

	1779.			1780.		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	0,1874	0	4	1,1250	3	11
February	0,4374	1	7	3,0936	3	13
March	0,5000	1	7	1,3124	2	16
April	1,1874	7	13	1,8124	9	14
May	2,3124	7	13	1,5624	5	15
June	2,2500	4	9	1,3436	4	10
July	4,0936	5	8	1,8436	5	10
Auguſt	0,7812	1	7	0,4374	1	5
September	3,4374	8	17	4,6562	10	14
October	2,5936	10	9	3,9062	8	14
November	3,0936	8	12	3,5312	8	14
December	5,6562	11	13	0,2186	2	6

	1781.			1782.		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	2,0000	7	5	2,3750	5	13
February	3,3750	9	9	0,7500	4	10
March	0,4686	0	7	1,8124	6	14
April	2,4062	3	10	4,0312	11	13
May	2,2812	3	6	3,9062	7	16
June	4,0936	8	7	1,2186	3	12
July	1,5936	2	8	1,9686	3	16
Auguſt	4,4686	10	9	6,5624	8	15
September	2,7500	6	11	3,1250	4	13
October	1,0000	1	16	2,8124	9	9
November	4,7812	11	8	2,4062	6	9
December	1,9686	5	10	1,9374	3	10

	1783.			1784.		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	4,1874	9	12	2,8436	4	11
February	2,9062	10	10	1,1250	5	10
March	2,3436	5	8	1,5624	3	14
April	0,5000	0	7	3,3124	8	15
May	3,2500	3	12	1,6874	2	8
June	3,3436	5	7	4,2812	8	10
July	3,1874	5	9	2,8436	4	8
Auguft	6,0936	8	13	3,6874	5	11
September	4,7812	9	9	1,8436	2	6
October	3,0312	6	10	0,7500	1	8
November	3,5312	6	8	3,3124	9	9
December	1,4062	2	11	3,0312	4	11

	1785.			1786.		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	2,2500	6	8	2,4686	6	14
February	1,0624	3	12	0,8750	4	9
March	0,8124	2	11	0,8750	5	9
April	0,6562	4	3	0,7186	2	9
May	1,0936	2	9	3,0624	2	14
June	1,3436	1	6	2,1250	5	9
July	1,6874	3	11	1,6874	6	9
Auguft	4,5936	6	15	3,1874	8	16
September	3,2812	5	17	4,5624	13	8
October	3,4062	10	9	1,5624	3	11
November	3,3750	9	4	2,1874	5	9
December	2,0624	5	14	3,0312	5	12

1787

	1787			1788		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	0,8750	4	6	1,8812	2	12
February	1,8436	6	15	2,4686	7	9
March	2,2186	8	8	2,2812	6	6
April	1,0936	4	11	1,8124	7	9
May	1,4062	1	10	1,6250	3	7
June	2,4062	5	11	1,4374	1	9
July	5,5624	9	12	4,2186	7	20
Auguft	3,2812	4	13	2,0936	5	10
September	1,6250	2	9	2,6874	6	14
October	9,1562	12	12	2,3124	6	8
November	3,8436	8	10	1,3436	2	5
December	4,7500	8	13	0,4374	4	7

	1789			1790		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	1,3750	4	13	3,9062	5	14
February	1,5000	5	11	1,0000	1	8
March	0,6562	4	11	1,2186	1	3 *
April	2,0312	3	14	1,9686	2	10
May	4,5000	4	14	4,6562	4	16
June	7,6562	9	13	3,0936	7	10
July	6,5000	8	18	5,4686	5	15
Auguft	1,7186	0	9	3,5312	4	14 †
September	5,8124	7	15	3,2500	5	12
October	7,7500	9	10	2,5312	3	8
November	4,1874	5	11	4,7812	7	8
December	5,0000	5	15	7,1562	8	11

1791

* March 1790, there were fix days on which no obfervation was taken.

† No obfervation was taken for the fame number of days in Auguft 1790.

	1791			1792		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	4,3124	4	14	2,7500	4	11
February	2,3750	5	12	2,2500	4	11
March	1,4374	2	6	2,5312	4	17
April	4,5624	6	14	6,5312	7	7
May	1,5000	2	10	6,3124	12	8
June	1,8750	3	12	2,5624	7	9
July	4,7812	6	12	3,7812	5	12
Auguſt	4,1250	6	10	6,1874	7	10
September	3,4374	2	7	8,0000	14	12
October	5,8436	11	6	4,4062	7	14
November	5,4062	7	15	2,2186	5	4
December	5,7500	10	10	6,7186	8	15

Mean quantity of rain in each of the preceding years at Liverpool.

1775	29,6785	1781	31,1866	1787	38,0616
1776	33,1866	1782	32,9054	1788	25,5988
1777	30,1768	1783	38,5616	1789	48,6870
1778	35,6238	1784	30,2802	1790	42,5616
1779	26,5302	1785	25,6240	1791	45,4056
1780	24,8426	1786	26,3428	1792	54,2492

Hence it appears, that the mean annual quantity of rain which falls at Liverpool, deduced from an average of 18 years, is 34,4168 inches.

Mr.

Mr. Hutchinſon's rain gage was placed at the top of his houſe, 41 feet above the higheſt water-mark.

Mean falls of rain at Liverpool in each month, and each ſeaſon of the year — from an average of eighteen years.

February	1,8471	May	2,5729
March	1,5227	June	2,8159
April	2,1041	July	3,6628
Mean falls in the Spring.	5,4739	Mean falls in Summer.	9,0516

Auguſt	3,3106	November	3,4408
September	3,6544	December	3,2876
October	3,7239	January	2,1741
Mean falls in Autumn	10,6889	Mean falls in Winter	8,9025

Mr. Hutchinſon did not begin his obſervations on the quantity of rain till the year 1775, —I ſhall therefore inſert the number of wet and variable days, extracted from his journal previous to that period.

	1768		1769		1770		1771		1772		1773		1774	
	Wet.	Variable.	W.	V.	W.	V.	W.	V.	W.	V.	W.	V.	W.	V.
January	3	14	5	9	12	9	7	12	9	7	8	7	3	8
February	6	10	8	6	5	9	4	5	7	11	6	8	10	5
March	1	6	7	6	8	9	9	4	10	10	1	7	5	0
April	8	7	8	6	7	6	4	8	6	4	10	7	11	8
May	4	8	5	8	6	9	6	6	8	8	13	9	6	8
June	7	7	13	6	12	7	3	5	10	9	5	6	11	8
July	10	9	5	9	9	9	10	9	4	4	6	10	6	14
August	5	10	8	14	5	6	8	15	8	8	2	9	5	9
September	8	9	11	7	15	7	3	11	12	8	15	11	8	10
October	7	6	7	4	10	10	10	8	7	11	10	11	1	15
November	11	6	10	7	13	6	10	7	16	8	13	10	10	8
December	11	5	7	9	14	6	7	9	3	9	10	4	5	7

Observations on the quantity of Rain at Dover, with the number of days on which there was rain or snow. From MR. MANTELL'S *Journal.*

As Mr. Mantell has only marked the days "rain" or "fair," the days on which there was rain could not be divided into wet and variable.

	1789		1790		1791		1792		1793	
	Rain.	Rainy days.	Rain.	Rainy days.	Rain.	Rainy days.	Rain.	Rainy days.	Rain.	Rainy days.
January			3,03	11	7,07	20	6,03	13	3,41	12
February			2,71	7	4,71	11	2,70	8	3,90	13
March			0,32	3	0,76	3	6,33	17	4,98	11
April			2,63	12	3,90	9	3,75	8	1,62	10
May			1,91	10	4,81	10	3,45	12	3,44	11
June			1,06	8	1,61	8	3,41	10	2,98	8
July			6,51	15	4,43	17	4,56	12	3,84	9
August			2,60	7	2,78	7	3,88	9	2,43	8
September			3,34	10	1,05	5	4,87	16	5,10	13
October	7,31		3,49	9	3,54	10	5,71	11		
November	5,19		5,05	10	5,52	16	2,38	8		
December	3,80		10,71	18	4,70	16	4,33	12		

Mean quantity of rain at Dover, in each of the preceding years.

1789	16,30
1790	43,36
1791	44,88
1792	51,40
1793	31,70

Mean annual falls 37,52 inches.

Observations on the Falls of Rain at Kendal and Waith-Sutton, by MR. GOUGH. *Continued from p.* 258.

	Kendal.			Waith-Sutton.	
	1792	1793	1794	1792	1793
January		6,3690	7,2984		3,41
February		8,0916	13,4724		5,29
March		4,5696	4,5304		3,26
April		1,5642	4,1808		1,30
May		1,8798	1,9998		1,81
June		3,3498	1,4574		2,95
July		3,5898	4,1604		3,75
August	7,2120	6,6798	5,3400	6,41	6,48
September	10,8348	2,4006	7,6746	9,00	2,54
October	5,7768	5,3526	7,3296	5,10	5,35
November	5,7414	3,6102	6,0114	4,24	3,84
December	12,688	7,2396	6,2040	10,15	4,87

Rain at Dumfries, in the year 1793, *by* MR. ALEX. COPLAND. *Continued from p.* 272.

Rain Gage one foot fquare.

1793.

	Quantity of falls.	Correfpond-ing depth.	Above the medium.	Below the medium.	Medium of each month for 16 years
	lb. oz. dr.	Inches.	Inches.	Inches.	Inches.
Jan.	11, 0,3	2,2111		,8838	3,0949
Feb.	29, 2,4	5,8395	3,002		2,8375
Mar.	20,15,6	4,2078	2,0436		2,1642
Apr.	4, 7,6	,9686		1,0483	2,0169
May	10,10,4	2,1368		,4313	2,5681
June	13,15,6	2,8041		,170	2,9741
July	6,12,3	1,3582		1,8978	3,2560
Aug.	20, 5,3½	4,0660	,8668		3,1992
Sep.	7, 4,4½	1,4608		2,8890	4,3498
Oct.	12, 7,5	2,5018		1,6416	4,1434
Nov.	12,15,1½	2,5966		,5570	3,1736
Dec.	19, 6,7	3,8883	,7468		3,1415
Total	170,15½	34,0396		2,8996	36,9392

Medium of the falls at Dumfries, in each feafon of the year 1793.

	Mean in each feafon.	Above the medium.	Below the medium.	Medium for the 16 pre-ceeding years.
Spring	11,0159	3,9973		7,0186
Summer	6,2991		2,4991	8,7982
Autumn	8,0286		3,6638	11,6924
Winter	8,6960		,714	9,4100

Falls

Falls of Rain at Kirkmichael, about eight miles North by Eaſt of Dumfries, near the bottom of high mountains, from the year 1773 *to* 1776 *incluſive, by the* Rev. Dr. Burgess. *Communicated by* Mr. Copland.

Mr. Copland remarks, that "the following obſervations (being for a period of near twenty years diſtant from his, and being made by one, whoſe accuracy and abilities for ſuch an undertaking are incontrovertible) are well calculated to anſwer the purpoſe for which theſe ſtatements are deſigned,"

Mean depth of falls in each month of 1773, 1774, 1775, and 1776.

January	February	March	April	May	June
3,133	4,612	2,040	3,387	,902	2,698
July	Auguſt	Sept.	Oct.	Nov.	Dec.
4,800	3,917	5,348	4,725	3,512	2,706

Annual mean 40,780 inches.

Falls

Falls of Rain at Keswick, by Mr. CROSTHWAITE, *Continued from p.* 38 *of* Mr. DALTON'S *Essays.*

	1793	1794
January	5,7131	5,7091
February	9,6491	11,1686
March	5,3214	6,4370
April	1,7878	5,3981
May	1,8430	3,2625
June	4,0404	1,6340
July	2,6400	2,5674
August	8,8483	3,1317
September	2,8825	8,1209
October	6,2219	9,4431
November	3,4090	6,8913
December	7,3448	8,0030

Rain at Garsdale, by Mr. THOMAS BLADES.

Garsdale lies N. E. of Kendal, at the distance of about thirteen miles. It is a narrow valley, some miles long, with very high hills on each side.

1777.

	1777		1778		1779	
	Rain.	Rainy Days.	Rain.	Rainy Days.	Rain.	Rainy Days.
January	2,2671	15	4,2380	21	1,5036	14
February	3,7507	16	1,9533	16	2,3802	14
March	3,9694	21	5,1516	24	1,4514	11
April	3,9848	13	2,6647	21	3,8320	20
May	2,2962	17	7,3690	23	4,7945	22
June	5,3209	19	3,3222	19	2,048	9
July	3,3704	17	7,6976	21	5,0178	17
Auguſt	5,6079	21	5,1213	15	1,0931	12
September	2,2937	16	4,1859	19	7,5633	27
October	6,9006	23	4,8353	20	8,7239	17
November	9,6546	25	5,7772	22	4,3384	17
December	3,1127	19	9,0499	28	3,2220	17
	49,5290	222	61,3660	249	45,9991	197

Account

Account of the Rain at Manchester, by Mr. George Walker. *Communicated by* Dr. Percival.

	1783	1784	1785	1786		1787		1788	
	Rain or Snow days.	Rain or Snow days.	Rain or Snow days.	Rain or Snow days.	Depth of Rain Inches L.	Rain or Snow days.	Depth of Rain I. L.	Rain or Snow days.	Depth of Rain I. L.
January	24	11	12	21	2,6	15	1,0	16	1,9
February	26	19	17	15	1,6	18	3,6	19	1,8
March	22	14	14	18	2,2	17	3,0	13	2,6
April	5	23	8	4	,11	10	1,9	17	1,10
May	8	12	11	21	3,6	10	2,9	9	1,10
June	15	27	11	12	4,0	13	2,6	7	1,0
July	14	19	16	20	2,8	26	7,8	30	4,10
August	20	18	22	25	6,6	20	3,8	20	3,9
September	12	8	23	22	7,10	13	2,2	21	2,0
October	12	7	23	13	2,9	21	9,0	9	2,10
November	4	17	15	12	1,5	14	5,8	8	2,4
December	21	13	21	24	4.8	23	4,10	9	1,0
	183	188	193	207	40,5	200	47,½	178	27,¼

	1789		1790		1791		1792		1793	
	Rain or ſnow days.	Depth of Rain. I. L.	Rain or ſnow days.	Depth of Rain. I. L.	Rain or ſnow days.	Depth of Rain. I. L.	Rain or ſnow days.	Depth of Rain. I. L.	Rain or ſnow days.	Depth of Rain. I. L.
January	21	2,0	21	2,3	29	5,6	19	2,0	22	2,75
February	24	5,4	11	1,3	23	3,0	16	2,0	26	3,75
March	23	1,6	6	1,0	12	1,6	24	2,9	25	2, 5
April	21	2,8	11	2,3	22	4,9	16	2,6	14	1,75
May	20	4,6	24	3,3	19	2,9	26	8,0	9	1, 5
June	22	6,6	19	5,6	8	0,9	24	3,6	20	2,65
July	31	7,3	23	5,9	22	3,6	24	3,9	11	1,25
Auguſt	11	0,10	24	4,6	19	6,0	18	6,3	20	6, 5
September	20	4,3	19	3,9	11	1,5	26	9,0	23	3, 3
October	23	5,9	14	2,9	23	4,6	17	4,0	21	4, 5
November	22	4,9	15	3,3	25	4,6	12	2,0	18	2, 5
December	25	5,8	23	7,3	20	5,10	26	9,6	24	3,55
	263	51	210	$42\frac{3}{4}$	233	44	248	$55\frac{1}{4}$	233	$36\frac{1}{2}$

The town of Mancheſter is ſituated about forty miles eaſt of the ſea. The ſurface of the river Irwell is about ſixty-three feet above low water mark at Liverpool.

State of the falls of Rain, &c. at Chatſworth, in Derbyſhire. Communicated to DR. PERCIVAL *by* LORD GEORGE CAVENDISH.

State of the perpendicular height of the Falls of Rain, &c. during the ſeven years preceding 1784.

	1777	1778	1779	1780	1781	1782	1783	Total in the ſame month of each year.
January	0,834	2,704	0,693	1,270	1,439	3,017	3,017	12,974
February	1,739	1,252	0,241	1,213	3,450	1,037	2,782	11,714
March	1,701	1,122	0,480	1,216	0,117	1,987	2,263	18,886
April	2,304	1,326	2,162	3,888	1,901	6,960	0,539	19,080
May	1,544	2,218	1,485	1,531	1,575	4,659	2,988	16,000
June	1,774	0,586	2,045	1,088	2;083	2,815	3,221	13,612
July	3,189	3,552	4,810	1,010	1,410	3,640	1,527	19,138
Auguſt	2,292	0,809	0,652	0,335	2,578	4,813	2,757	14,236
September	1,223	1,817	3,030	3,276	2,597	4,451	5,816	22,210
October	5,019	6,377	3,298	4,093	0,109	2,287	1,832	23,015
November	1,741	2,991	1,689	1,281	3,614	1,557	2,412	15,285
December	1,434	5,141	3,977	0,240	2,172	1,893	0,372	15,229
Total in each year	24,794	29,895	24,562	20,441	23,045	39,116	29,526	191,379

The average of the annual falls, for the ſeven years commencing with 1777, is 27,339 inches.

The average falls in each month, during ſeven years commencing with 1777, claſſed according to the ſeaſons.

SPRING.		SUMMER.	
February	1,673	May	2,285
March	1,269	June	1,944
April	2,725	July	2,734
Mean falls in Spring.	5,667	Mean falls in Summer.	6,963

AUTUMN.		WINTER.	
Auguſt	2,033	November	2,183
September	3,173	December	2,175
October	3,288	January	1,853
Mean falls in Autumn.	8,494	Mean falls in Winter.	6,211

State

State of the perpendicular height of the falls of rain, &c. at Chatſworth, during the ſeven years preceding 1791.

	1784	1785	1786	1787	1788	1789	1790	Total in the ſame month of each year.
January	2,439	1,136	3,607	0,652	1,723	2,118	50	13,925
February	1,410	0,374	1,104	2,130	2,532	3,616	0,461	11,627
March	1,206	0,786	1,164	3,556	1,438	1,120	0,513	9,783
April	2,388	0,122	0,883	1,174	1,078	2,206	0,512	8,363
May	1,882	0,863	2,804	1,569	1,725	2,379	2,778	14,000
June	4,020	1,121	1,910	1,375	2,756	4,851	2,963	18,996
July	3,552	2,438	1,211	6,166	2,332	5,617	2,620	23,936
Auguſt	1,938	4,022	3,927	2,547	2,145	1,201	2,468	18,248
September	1,047	2,767	3,910	1,823	1,724	3,582	2,556	17,409
October	0,455	3,710	3,067	4,290	1 693	4,483	1,732	19,430
November	2,257	2,718	3,877	3,279	0,597	2,443	3,748	18,919
December	0,382	3,105	3,212	3,507	0,113	2,693	4,291	17,303
Total in each Year.	22,976	23,162	30,676	32,068	19,856	36,309	26,892	161,939

The average of the annual falls, for the ſeven years commencing with 1774, is 27,419 inches.

The average falls in each month, during the feven years commencing with 1784, claffed according to the feafons.

SPRING.		SUMMER.	
February	1,661	May	2,000
March	1,397	June	2,713
April	1,194	July	3,419
Mean falls in Spring	4,252	Mean falls in Summer.	8,132

AUTUMN.		WINTER.	
Auguft	2,606	November	2,702
September	2,487	December	2,471
October	2,775	January	1,989
Mean falls in Autumn	7,868	Mean falls in Winter	7,162

The average of falls in each feafon, for fourteen years preceding 1791, is as under:

Spring	-	4,959
Summer	-	7,547
Autumn	-	8,181
Winter	-	6,686.

State

State of the perpendicular height of the falls of rain at Chatfworth, in the years 1791, 1792, and to the month of Auguft, 1793.

	1791	1792	1793
January	6,373	1,870	1,926
February	2,061	1,042	1,616
March	0,707	1,783	2,306
April	2,511	3,309	2,536
May	0,779	3,121	0,749
June	1,023	2,961	0,773
July	2,508	2,525	0,657
Auguft	3,665	2,822	
September	2,506	4,508	
October	3,333	3,487	
November	5,951	2,003	
December	3,281	5,309	
Total in each year.	34,698	34,740	

Amount of the falls in each feafon throughout the year 1791, compared with the medium during the preceding fourteen years, during the fame feafons.

	Depth of falls.	Above the medium.	Below the medium.	Medium for 14 years.
Spring	5,279	,320		4,959
Summer	4,310		3,237	7,547
Autumn	9,504	1,323		8,181
Winter	15,605	8,919		6,686
Throughout the year.	34,698	10,562	3,237	27,373

Amount

Amount of the falls in each season throughout the year 1792, compared with the medium for the preceding fifteen years during the same seasons.

	Depth of falls.	Above the medium.	Below the medium.	Medium for 15 years.
Spring	6,134	1,153		4,981
Summer	8,607	1,276		7,331
Autumn	10,817	2,547		8,270
Winter	9,182	1,899		7,283
Throughout the year.	34,740	6,875		27,865

Account of the perpendicular height of the Rain that has fallen at Lancaster, by Dr. Campbell. *Continued from p. 365.*

	1791		1792		1793	
	In.	Lines	In.	L.	In.	L.
January	5	10	3	2	4	6
February	3	$1\frac{3}{4}$	3	0	3	$8\frac{1}{2}$
March	2	2	5	9	2	8
April	4	3	5	$9\frac{1}{2}$	1	11
May	2	$4\frac{1}{4}$	5	0	0	10
June	0	$10\frac{1}{2}$	3	10	3	5
July	3	6	5	$1\frac{1}{2}$	2	10
August	6	2	8	6	5	6
September	1	$9\frac{1}{2}$	9	4	3	4
October	3	10	4	3	4	8
November	6	6	4	0	3	$9\frac{1}{2}$
December	5	$7\frac{1}{2}$	8	1	4	8
Total	46	$0\frac{1}{2}$	65	10	41	0

State

State of the falls of Rain at Youngsbury near Ware, in Hertfordshire, twenty miles from London. This state was communicated to me by Mr. Gough, of Kendal, who says he is indebted for it to Mr. Samuel Lloyd of Birmingham, to whom it was transmitted by a Lady, who had paid particular attention to the subject.

	1787	1788	1789	1790	1791
January	1,300	1,440	2,471	2,050	3,360
February	2,210	2,090		0,280	1,910
March	2,163	1,130	4,894	0,200	0,980
April	1,630	0,297		1,660	1,950
May	0,930	0,410	1,730	3,210	0,880
June	0,810	2,042	3,910	0,810	0,800
July	3,617	1,313	3,601	3,510	2,960
August	1,580	3,310	1,310	1,960	1,740
September	0,890	3,780	2,754	0,770	0,800
October	3,962	0,140	4,265	1,110	2,420
November	1,542	0,930	2,830	3,690	3,630
December	3,030	0,794	1,730	3,720	2,770
Total	23,664	17,676	29,493	22,970	24,200

A Synoptical Table of the Falls of Rain at different Places in the fame Years.

Years.	Liverpool.	Manchefter.	Dumfries.	Kendal.	Kefwick.	Lancafter.	Chatfworth.	Dover.	Youngfbury.	Garfdale.	Waith-Sutton.	Fellfoot.
1775	29,6785											
1776	33,1866											
1777	30,1768		34,749				24,794			49,5290		
1778	35,6238		42,354				29,895			61,3660		
1779	26,5302		41,135				24,562			45,9991		
1780	24,8426		40,033				20,441					
1781	31,1866		29,988				23,045					
1782	32,9054		40,918				39,116					
1783	38,5616		33,994				29,526					
1784	30,2802		27,401			35,15	22,976					
1785	25,6240		30,673			36,83	23,162					
1786	26,3428	40,5	32,008			32,30	30,676					
1787	38,0616	47,½	38,657			51,01	32,068		23,664			
1788	25,5988	27,⅓	26,423	39,2575	34,3057	29,45	19,856		17,676			42,06
1789	48,6870	51	48,093	69,835	72,2449	51,01	36,309		29,493		48,30	66,52
1790	42,5616	42,¾	39,354	66,263	64,7439	46,61	26,892	43,36	22,970		45,22	58,48
1791	45,4056	44	39,281	62,200	73,5522	46,05	34,698	44,88	24,200		41,68	
1792	54,2492	55,¼	47,513	84,884	84,6051	65,10	34,740	51,40			57,57	
1793		36,½	34,039	45,580	49,7510	41,00					37,37	
1794				58,048	59,8050							

A FEW OBSERVATIONS ON RAIN GAGES.

RAIN GAGES, it muft be allowed, are imperfect inftruments, and that on two accounts: Firft, from the evaporation which very commonly takes place on the interior furface of the funnel during wet weather in fummer; for the air is, for the moft part, in a condition to abforb more water than it contains, though (as Mr. Gough obferves in a letter which I received from him) our humid atmofphere is fometimes fo perfectly faturated, as to depofit a part of its vapour on furniture within doors, even during the months of July and Auguft, provided the weather be very wet; but water will frequently evaporate from the furfaces of many bodies, particularly metallic fubftances, while rain is falling in fummer, or dew is forming in an evening: for if a veffel of tinned iron be rubbed with a wet fponge, and then fufpended with its mouth downwards, its inner furface will foon become dry, though rain be falling, or dew forming at the time.

It is certainly neceffary to afcertain, if poffible, the quantity of water loft by evaporation; for

for according to an ingenious Italian philoſopher, nearly double as much water evaporates from an open veſſel, as falls into it in the form of rain.* Now, though an evaporation gage may aſcertain the quantity of water which evaporates from an open veſſel of a given aperture, yet it will by no mean aſcertain the ratio between the quantity evaporated from the internal ſurface of the funnel, and the whole quantity received by the gage. Mr. Gough propoſes an ingenious method of determining this point by means of two contiguous gages. For, let A and $a =$ the areas of the apertures of the two gages, B and $b =$ the curve ſurfaces of their funnels, S and $s =$ the quantities of water collected by them in a given time in grains, X and $x =$ the quantities loſt by evaporation. Then $S + X$ and $s + x$ being the quantities received by the gages, we have $A : a :: S + X : s + x$, and $x = \frac{aS - As + aX}{A}$; but ſince the quantities evaporated in the ſame time are as thoſe ſurfaces, $B : b :: X : x$, and $x = \frac{bX}{B} = \frac{aS - As + aX}{A}$, hence $X =$

 BaS

* Vide Opere del Padre Giovanni Baptiſta da St. Martino. Vol. I. Art. 4.

$\frac{BaS - BAs}{Ab - Ba}$; but the funnels of the two gages muſt not be ſimilar, for, in that caſe, the numerator and denominator would be $= o$, and conſequently nothing could be determined.

The ſecond imperfection to which rain gages are liable, ariſes from the loſs of water occaſioned by the drops of rain burſting, when they are driven obliquely by a breeze, and ſtrike the ſides of the gage: in ſuch cases, they diſperſe into a number of minute drops, many of which never deſcend into the receiver, but eſcape over the margin of the funnel. This depends on principles too ſimple to require any experimental proof. It is difficult, if not impoſſible, to prevent entirely the waſte of rain by diſperſion; all that we can do is to diminiſh it as much as poſſible. Mr. Gough, in the ſame letter, propoſes the following method of remedying this imperfection. A linen ſtrainer, he ſays, of a conical figure, ſhould be exactly fitted to the mouth of the gage; this flexible funnel ſhould be ſtretched by a weight or ſtring faſtened to its apex within the veſſel; the drops, ſtriking on this yielding ſubſtance, would receive a moderate concuſſion, and the particles of water would be entangled in the threads of the cloth. It is ſufficiently evident, that this contrivance would greatly prevent the loſs occaſioned by diſperſion,

ſion; but would, at the ſame time, much increaſe the evaporation, by detaining a quantity of water in the funnel, and expoſing a much greater ſurface to the air. A better way of correcting this error, is, I think, to have a perpendicular rim an inch or two high, fixed to the rim of the funnel. The form of the gages which I have had conſtructed for my own uſe, and that of my friends, is repreſented in the annexed Plate. (IX. fig. 2.)

In gages of this form, eſpecially when made ſufficiently large, Mr. Copland, of Dumfries, informs me, that he found the loſs from diſperſion nearly, if not entirely, corrected. The area of one of his funnels contains 144 ſquare inches, and the other 288. He has compared theſe with one of an area of ſixteen inches, and always found a ſmaller than proportional reſult from this laſt in windy weather. He ſays, he has obſerved his large ſquare gages in ſtormy falls, and could obſerve nothing driven over after having ſtruck the inſide, and was ſurprized to ſee ſo little loſt even during a hail ſhower. He recommends gages with ſquare apertures, in preference to thoſe of a cylindrical or conical form; for " from the rotatory motion which the air always takes when forced over the end of a tranſverſely truncated cylinder, and which emits a whiſtling noiſe, the rain will be carried over the edge of the cylinder, and be almoſt entirely

entirely prevented from falling into the gage." He ſoon found, he ſays, after uſing ſquare gages, that the reſults from them were much more ample than from ſome others that were kept in the neighbourhood, which were of a cylindrical form.

A little cup, with its mouth downwards, is fitted to the neck of the funnel as at *A*, which will go over the mouth of the bottle; becauſe it is evident, that when rain is driven againſt the outſide of the funnel, or in conſequence of the condenſation of dew upon the outer or under ſide of it, more water would be collected by the receiver than falls within the area of the funnel, if it was not prevented by a contrivance of this kind.

In order to determine the perpendicular height of water which falls upon the ground by means of a rain gage:—If we know the weight of water caught in the bottle, the area of the aperture of the funnel, and the weight of the cubic foot of water, we can eaſily calculate the perpendicular height. Mr. Dalton, in his Meteorological Eſſays, (page 34) has given a theorem for this purpoſe: but upon comparing tables which I had conſtructed for my own uſe by this theorem, with ſome which were ſent me by Mr. Kirwan, I found that the height given in mine much exceeded that in the tables of this

laſt

laſt-mentioned gentleman. I therefore ſet about the inveſtigation of Mr. Dalton's theorem, and from the ſame principles obtained an expreſſion which was only $\frac{1}{12}$ of his. But diſtruſting my own inveſtigation, when contraſted with the known abilities of Mr. Dalton as a mathematician, I wrote to my friend Mr. Dawſon, of Sedbergh, deſiring his opinion on the ſubject, and his anſwer is as follows—" There is certainly a miſtake in Mr. Dalton's theorem for determining the height of water fallen upon a given horizontal plane, as you will eaſily ſee from what follows.

" Beſides the ſymbols he makes uſe of (viz. $a =$ the area of the aperture of the funnel, W the weight of a cubic foot of water, and w the weight of the water caught in pounds), put $x =$ the depth of the water fallen in inches, then $ax =$ the number of ſolid inches in the gage, and becauſe the weight varies as the number of ſolid inches, $\therefore W : w :: 1728 : ax$, and $ax \times W = 1728 \times w$, or $x = \frac{1728\,w}{a\,W} =$ depth required.—Mr. Dalton's expreſſion is juſt twelve times the above. You will eaſily obſerve that the 1728 is the number of cubic inches in a ſolid foot, of which $W =$ the weight in avoirdupoiſe pounds."

The eaſieſt way of finding the perpendicular height of water fallen, is to meaſure the water caught

caught in a phial graduated ſo as to expreſs the weight of the water in ounces and quarters, and to compare this with a table conſtructed for the purpoſe.—As many people may wiſh to keep a rain gage, who are unacquainted with the method of conſtructing theſe tables, I ſhall give one which I formed for my own uſe.—It will likewiſe ſave trouble to thoſe who can conſtruct them themſelves.—It is calculated for a gage whoſe aperture is a ſquare foot. The heights correſponding to different weights (Troy) of water, are expreſſed in inches and decimal parts.

Weight.		Correſponding heights.	Weight.	Correſponding heights.
lb.	oz.	Inches.	lb.	Inches.
0	$\frac{1}{4}$	0,00328	1	0,15763
0	$\frac{1}{2}$	0,00656	2	0,31527
0	1	0,01313	3	0,47291
0	2	0,02626	4	0,63054
0	3	0,03940	5	0,78817
0	4	0,05250	6	0,94582
0	5	0,06560	7	1,10345
0	6	0,07881	8	1,26018
0	7	0,09194	9	1,48171
0	8	0,10507	10	1,57634
0	9	0,11822	11	1,73397
0	10	0,13135	12	1,89160
0	11	0,14448		

Suppoſe

Suppoſe the water found in the gage upon examination to weigh 2lb. 8¼oz. Then we have by the table

2lb.	-	0,31527
8oz.	-	0,10507
¼oz.	-	0,00328
Perpendicular height		0,42362

I have been thus particular, becauſe many perſons unacquainted with ſcience, may be induced to keep rain gages, when the method of doing it is made eaſy—and thus will our general ſtock of obſervations be increaſed.

§ IV.

OF THE WINDS.

Obſervations on the Winds at Liverpool, abſtracted from Mr. Hutchinson's *Journal.*

Concerning the method which Mr. Hutchinſon took to eſtimate the velocity of the winds,

 I ſhall

I fhall infert an extract of a letter which I received from Dr. Renwick, who, at my requeft, had the goodnefs to make inquiries of Mr. Hutchinfon.

"Concerning the velocity of the winds, Mr. H. could not fay he was very exact during two or three of the firft years of the Journal, as he noted it down from his own judgement; he afterwards tried it by the method of finding the fhip's velocity by heaving the log. He faftened a fhip's log-line about his waift, while fome perfon who underftood the nature of it, attended to the log glafs, and line. He made ufe of a common walking-ftick, to the end of which he affixed a crofs ftick (fimilar to the yard of a fhip,) and to the end of the crofs ftick he affixed a filk handkerchief. As he ran, the handkerchief was carried forwards by the wind, and when the handkerchief fell flat upon the ftick, he judged that he had run as faft as the greateft velocity of the wind. He alfo tried a fimilar experiment with a boat, which had two fails before the wind in fmooth water, in fuch as a ftiff-failing fhip might carry her top-gallant fails."

In

In the following table, D signifies the number of days which the wind has blown from that point during the year; G the greatest velocity of the wind; L the least velocity; and M the mean velocity.

North

	North				N. E.				Eaſt				S. E.			
Years.	D.	G.	L.	M.	D.	G.	L.	M.	D.	G.	L.	M.	D.	G.	L.	M.
1768	11	25	10	18	24	50	5	21	36	35	15	25	86	40	10	22
1769	10	30	20	22	25	40	10	20	15	40	10	23	89	45	10	22
1770	27	30	5	15	29	45	5	17	13	40	5	13	69	35	5	11
1771	21	30	3	7	26	40	3	6	18	30	3	10	84	35	2	10
1772	12	10	3	7	24	20	3	7	13	25	3	8	137	30	2	7
1773	13	10	3	7	14	20	5	8	10	25	2	6	136	40	2	6
1774	19	20	4	7	29	40	3	8	22	25	3	7	135	40	2	6
1775	13	8	3	5	13	10	3	5	11	15	5	8	124	30	2	6
1776	9	12	3	5	19	30	3	7	19	30	3	6	126	20	2	6
1777	16	10	3	5	37	15	3	6	12	25	3	7	115	25	2	7
1778	13	20	3	6	30	20	2	6	8	15	3	8	137	25	2	6
1779	10	10	3	6	21	10	3	5	13	10	5	7	143	20	2	6
1780	15	20	3	7	30	20	3	6	14	10	5	7	113	20	3	6
1781	5	15	5	9	20	15	5	7	16	10	3	6	141	30	3	7
1782	20	20	3	10	40	15	3	7	18	30	3	9	105	20	2	9
1783	13	15	3	8	34	20	3	6	20	15	3	9	140	25	3	7
1784	20	15	3	7	37	20	3	8	26	15	3	8	95	20	2	6
1785	10	8	3	6	28	15	3	7	19	15	5	9	132	30	2	7
1786	4	8	3	5	46	20	3	8	28	20	5	11	105	20	3	8
1787	13	20	3	7	34	20	3	8	15	35	5	11	124	35	2	9
1788	14	20	3	7	50	20	3	8	23	20	5	9	112	20	3	7
1789	13	10	3	5	28	15	3	7	18	40	3	9	121	20	3	7
1790	8	8	5	6	32	30	3	7	23	20	3	8	102	10	3	6
1791	11	10	5	7	34	20	3	6	25	8	5	7	97	20	3	7
1792	15	20	3	7	28	10	3	6	24	10	5	8	114	20	3	7

South

	South				S. W.				West.				N. W.			
Years.	D.	G.	L.	M.	D.	G.	L.	M.	D.	G.	L.	M.	D.	G.	L.	M.
1768	26	30	10	21	40	40	15	24	40	45	10	27	33	40	10	23
1769	19	35	10	19	61	45	10	28	32	45	10	26	61	50	10	24
1770	18	15	3	6	50	45	5	19	64	50	3	16	56	50	5	17
1771	12	12	3	7	42	40	3	13	50	45	3	16	67	40	3	9
1772	18	20	2	6	56	22	3	10	45	30	3	11	46	40	2	7
1773	7	7	5	5	50	45	3	8	45	30	3	11	55	25	3	7
1774	4	5	3	4	47	20	3	9	54	30	3	12	51	30	3	10
1775	9	7	3	5	54	45	3	12	53	30	3	12	63	25	3	10
1776	8	10	3	6	46	30	2	9	52	40	2	11	64	30	3	8
1777	8	10	2	4	36	30	3	11	54	30	3	11	51	20	2	7
1778	4	10	3	7	59	40	2	11	39	30	2	12	54	20	3	8
1779	10	8	3	6	57	30	3	10	40	30	3	11	62	30	2	8
1780	4	5	3	5	62	30	3	10	46	35	3	12	63	25	3	10
1781	6	8	3	5	53	30	2	10	47	30	3	11	71	30	3	11
1782	2	10	7	8	65	25	3	13	66	35	3	13	48	30	3	13
1783	5	10	5	7	51	40	5	12	39	30	3	12	57	20	3	9
1784	8	8	3	4	52	30	3	10	53	30	3	11	55	15	3	10
1785	9	15	3	7	42	30	3	11	58	35	3	15	71	25	3	10
1786	10	10	2	5	54	40	3	12	50	40	2	13	57	30	3	9
1787	9	25	3	6	66	40	3	14	47	30	3	11	56	45	3	7
1788	11	10	3	6	46	40	3	12	58	30	3	9	53	40	3	9
1789	7	30	3	11	71	40	3	11	39	30	3	11	42	25	3	9
1790	4	8	5	6	54	15	3	11	56	30	3	11	55	20	3	7
1791	3	7	3	5	70	50	3	11	55	40	3	11	51	40	3	10
1792	6	15	5	7	69	30	5	9	45	40	5	9	47	25	3	8

The

The annual mean deduced from this table is as follows;

North.		N. E.		Eaſt.		S. E.	
No. of days.	Mean velocity	No. of days.	Mean velocity	No. of days.	Mean velocity	No. of days.	Mean velocity
13	8	29	8	18	9	115	8

South.		S. W.		Weſt.		N. W.	
No. of days.	Mean velocity	No. of days.	Mean velocity	No. of days.	Mean velocity	No. of days.	Mean velocity
9	7	54	12	49	13	58	10

Taking the North and Eaſt winds in oppoſition to the South and Weſt, they will ſtand as follows.

	Days.	M. V.
North - -	13	- - 8
N. E. - -	29	- - 8
Eaſt - -	18	- - 9
S. E. - -	115	- - 8
Total of the North Eaſterly winds.	175	Mean Velocity of N. E. winds. $8\frac{1}{4}$

	Days.	M. V.
South - -	9	- - 7
S. W. - -	54	- - 12
Weſt - -	49	- - 13
N. W. - -	58	- - 10
Total of the South Weſterly winds.	170	Mean Velocity of S. W winds. $10\frac{1}{2}$

State

State of the direction and mean velocity of the winds in each month, deduced from an average of twenty-five years.

Months.	North.		N. E.		East.		S. E.		South.		S. W.		West.		N. W.	
	Days.	Mean Velocity.	D.	M.V.	D.	M.V.	D.	M.V.	D.	M.V.	D.	M.V.	D.	M.V.	D.	M.V
January	1	9	3,5	9	2,1	13	7,8	8	0,5	7	3,4	13	3,9	13	5,	12
February	0,92	11	2,28	10	1,16	11	8,3	9	0,8	10	5,5	14	4,16	15	2,5	10
March	1,4	8	3,9	10	1,9	11	9,4	9	0,6	9	4,8	12	4	13	3	9
April	1	9	3,5	9	2,1	13	7,8	8	0,5	7	3,4	13	3,9	13	5	12
May	0,8	8	3	10	1,8	10	9,7	7	1	7	3,6	13	3	12	7	9
June	0,8	9	2	7	1,3	8	7,8	7	0,8	7	3,7	14	4,7	10	6,8	8
July	0,6	7	1	7	0,4	8	7,5	7	1	7	4,7	11	6	9	8	8
August	0,7	8	0,7	7	1,3	10	9	7	0,9	8	4	10	5,6	12	6	8
September	0,7	7	1,6	7	1,4	9	12	8	0,5	7	5	10	3,4	12	4	9
October	1,2	7	2,3	7	2	9	11	8	1	8	5	11	3	12	2,7	8
November	1,2	9	3	8	1,2	9	10	9	0,7	8	3,9	12	3,5	15	3,3	14
December	1,8	7	2,4	7	1,5	8	10,5	8	0,8	6	4	13	4	16	2,6	12

Obſervations on the Winds at Dover, abſtracted from Mr. Mantell's Journal.

	1790.								1791.								1792.							
	N	NE	E	SE	S	SW	W	NW	N	NE	E	SE	S	SW	W	NW	N	NE	E	SE	S	SW	W	NW
January	1	6	0	6	2	22	3	5	2	2	0	1	2	29	8	7	5	14	0	6	3	15	1	4
February	0	2	0	1	0	23	3	6	7	10	1	2	1	14	5	7	2	10	1	1	1	14	0	12
March	2	22	4	6	0	10	0	5	5	9	0	1	0	19	1	15	0	5	0	1	1	25	0	5
April	2	16	7	6	2	8	1	3	3	12	6	2	0	17	2	3	0	13	0	1	0	14	0	11
May	4	14	2	5	0	16	0	1	2	15	0	0	1	16	5	8	3	12	0	1	1	12	5	9
June	0	12	0	1	1	19	3	7	4	16	1	2	0	11	1	7	2	8	1	1	0	15	5	8
July	2	3	0	0	0	26	0	6	3	3	3	0	0	22	2	7	4	6	0	3	1	19	4	7
Auguſt	4	3	0	3	0	25	5	8	3	9	0	0	0	19	5	2	1	18	2	5	0	6	1	9
September	2	9	1	6	0	18	3	8	3	14	4	7	0	9	4	7	3	2	1	1	0	11	7	16
October	3	14	4	11	0	15	2	5	3	9	1	10	2	14	6	8	0	11	5	4	2	13	1	6
November	1	12	4	9	2	13	1	2	2	5	0	7	0	17	5	3	1	7	2	3	0	15	4	6
December	5	6	1	2	1	23	2	10	3	8	1	5	2	14	4	9	3	7	2	1	0	8	7	22
Total in each year	27	129	23	46	8	218	23	66	30	112	17	37	8	201	48	93	24	113	14	28	9	167	33	115

Upon an average of three years, the winds have blown as follows.

North	N. E.	Eaſt.	S. E.
27	118	18	37

South.	S. W.	Weſt.	N. W.
8	195	35	91

Taking the North and Eaſt winds in oppoſition to the South and Weſt, they will ſtand as follows.

	Days.		Days.
North -	27	South -	8
N. E. -	118	S. W. -	195
Eaſt -	18	Weſt -	35
S. E. -	37	N. W. -	91
	200		329

State of the Winds in each Month, on an average of three Years.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
January	2,7	7,3	0	4,3	2,3	22	4	5,3
February	3	7,3	0,7	1,3	0,7	17	2,7	8,3
March	2,7	12	1,3	2,7	0,3	18	0,3	8,3
April	1,7	13,7	4,3	3	0,7	13	1	5,7
May	3	13,7	0,7	2	0,7	14,7	3,3	6
June	2	12	0,7	1,3	0,3	15	3	7,3
July	3	4	1	1	0,3	22,3	2	6,7
Auguſt	2,7	10	0,7	2,7	0	16,7	0,3	6,3
September	2,7	8,3	2	4,7	0	12,7	4,7	0,3
October	2	11,3	3,3	8,3	1,3	14	3	6,3
November	1,3	8	2	6,3	0,7	15	3,3	3,7
December	3,7	7	1,3	2,7	1	15	3,7	13,7

Observations on the Winds at Dumfries, by Mr. Copland, continued from p. 272.

In 1793 the wind was	No. of days.	Above the Medium.	Below the Medium.	Medium for 9 Yrs.
North	32		4,17	36,17
N. W.	26	1,45		24,55
East	77	10,33		66,67
N. E.	15		,5	15,5
Total of the N. E. winds.	150	7,11		142,89

In 1793 the wind was	No. of days.	Above the Medium.	Below the Medium.	Medium for 9 Yrs.
South	75		1,11	76,11
S. E.	18		2,16	20,16
West	61½		12,79	74,29
S. W.	60½	8,95		51,55
Total of the South Westerly winds.	215		7,11	[illegible]22,11

Prevalence of the South Westerly Winds 65 Days.

Before

Before the publication of the BOTANIC GARDEN, the world was not in poſſeſſion of any rational theory of the winds; that of Dr. Halley, and others which have ſucceeded it, not being ſufficient to explain a variety of phenomena, and being evidently contradicted by ſome. Since Dr. Darwin's theory appeared, Mr. Dalton has publiſhed one on ſimilar principles, which (as I believe he was totally unacquainted with Dr. Darwin's at the time he wrote) is a circumſtance certainly not unfavourable to the theory. As many of the phenomena of meteorology admit of an eaſy and ſatisfactory explanation by Dr. Darwin's theory, and as ſome circumſtances relative to the winds at Liverpool, cannot be well underſtood without it, I ſhall tranſcribe a ſhort outline of it, which the ingenious author gives by way of recapitulation.

"NORTH-EAST WIND conſiſts of air flowing from the North, where it ſeems to be occaſionally produced; has an apparent direction from the Eaſt, owing to its not having acquired, in its journey, the increaſing velocity of the earth's ſurface. Theſe winds are analogous to the trade winds between the tropics, and frequently continue in the vernal months for four and ſix weeks together, with a high barometer, and fair or froſty weather. 2. They

 ſome-

ſometimes conſiſt of South-weſt air which had paſſed by us or over us, driven back by a new accumulation of air in the North. Theſe laſt continue but a day or two, and are attended with rain.

South-West Wind conſiſts of air flowing from the South, and ſeems occaſionally abſorbed at its arrival to the northern latitudes. It has a real direction from the weſt, owing to its not having loſt in its journey the greater velocity it had acquired from the earth's ſurface from whence it came. Theſe winds are analogous to the monſoons between the tropics, and frequently continue from four to ſix weeks together, with a low barometer, and rainy weather. 2. They ſometimes conſiſt of north-eaſt air, which had paſſed by us or over us, which becomes retrograde by a commencing deficiency of air in the north. Theſe winds continue but a day or two, attended with ſevere froſt with a ſinking barometer; their cold being increaſed by their expanſion as they return into an incipient vacancy.

North West Winds conſiſt, firſt, of South-weſt winds, which have paſſed over us, bent down and driven back towards the ſouth, by the newly generated northern air. They continue but a day or two, and are attended with rain or clouds. 2. They conſiſt of north-eaſt winds,

winds, bent down from the higher parts of the atmofphere; and, having there acquired a greater velocity than the earth's furface, are frofty and fair. 3. They confift of north-eaft winds, formed into a vertical fpiral eddy, as on the eaftern coafts of North America, and bring fevere froft.

South-East Winds confift, firft, of North-Eaft winds become retrograde; continue for a day or two: frofty or fair, finking barometer. 2. They confift of North-Eaft winds formed into a vertical eddy, not a fpiral one; froft or fair.

North Winds confift, firft, of air flowing flowly from the North, fo that they acquire the velocity of the earth's furface as they approach; are fair or frofty; feldom occur. 2. They confift of retrograde fouth winds; thefe continue but a day or two; are preceded by fouth-weft wind; and are generally fucceeded by north-eaft winds, cloudy or rainy, barometer rifing.

South Winds confift, firft, of air flowing flowly from the fouth, lofing their previous weftern velocity by the friction of the earth's furface as they approach; moift, feldom occur. 2. They confift of retrograde north winds; thefe continue but a day or two; are preceded by

north-eaft;

north-eaſt winds; and generally ſucceeded by ſouth-weſt winds, colder, barometer riſing.

East Winds conſiſt of air brought haſtily from the north, and not impelled farther ſouthward, owing to a ſudden beginning abſorption of air in the northern regions; very cold; barometer high; generally ſucceeded by ſouth-weſt winds.

West-Winds conſiſt of air brought haſtily from the ſouth, and checked from proceeding further to the north by a beginning production of air in the northern regions, warm and moiſt, generally ſucceeded by north-eaſt wind. 2. They conſiſt of air bent down from the higher regions of the atmoſphere; if this air be from the ſouth, and brought haſtily, it becomes a wind of very great velocity, moving perhaps ſixty miles an hour, is warm and rainy; if it conſiſt of northern air bent down, is is of leſs velocity, and colder."

From this theory we may conclude, that all our winds in this country which blow from the north or eaſt, or any point between them, conſiſt of regions of air brought from the north; and that all our winds blowing from the ſouth or weſt, or from any point between them, are regions of air from the ſouth; and that, in places where there are no local circumſtances which divert the winds from the courſe they would

would naturally take, the north-eaft and fouth-weft winds will be moft frequent; as is the cafe at Dover, Lancafter, Kendal, &c. At Liverpool, however, a remarkable deviation takes place. From the tables here given it appears, that the wind blows much more frequently from the fouth-eaft than from any other point; and on comparing it with the winds at Dover, in the table here given, with the winds at Lancafter, p. 265 of this volume, and thofe of Kendal in Mr. Dalton's Effays, it appears, that both the fouth-weft and the north-eaft winds at Liverpool are deficient. As this takes place conftantly every year, it can only be accounted for on the fuppofition of fome permanent local caufe. It probably depends upon an atmofpheric eddy, produced by the fouth-weft winds ftriking obliquely againft the Englifh appenine, and being hence converted into fouth-eaft winds. The fame will happen, in fome degree, to the north-eaft winds. This eddy is probably fimilar to that, which caufes the frequent north-weft winds on the eaftern coaft of North America. Thefe are the freezing winds, as appears from a variety of teftimonies, and are evidently produced by an atmofpheric eddy: for when a fheet of air is flowing from the north-eaft, and rifing from the fhore in a ftraight line to the fummit of the Apalachian mountains,

mountains, a part of the ſtream of north-eaſt air will flow over the mountains, another part will revert and circulate ſpirally between the ſummit of the country and the eaſtern ſhore, continuing to move towards the ſouth; and thus be changed from a north-eaſt to a north-weſt wind. (See Botanic Garden, part 1ſt).

In a letter which I lately received from Dr. Darwin, he coincides with me in opinion, that "the prevalence of the ſouth-eaſt winds at Liverpool, depends upon ſome atmoſpheric eddy produced by the ſituation of the place." In the ſame letter this ingenious philoſopher obſerves, "that the knowledge of the winds, their origin or cauſe, is the principal ſource (I mean the cauſe) not the conſequence of all the other atmoſpheric phænomena in my opinion. All the winds of the N. E. come directly from ſnowy countries; and as the ſnow is evaporated by them, great cold is produced: firſt by the thawing of the ſnow into water, and then by evaporating the water, which I ſuppoſe to be done at one proceſs by the air. Then the ſouth-eaſt winds, when they bring froſt, are ſuperior currents of north-eaſt winds driven back. Theſe I eſteem to be the ſources of froſt in this country. And how theſe winds are produced or generated for ſix weeks together, ſeems to me to be the greateſt deſideratum, as I have endeavoured to ſhow in a note in the Botanic Garden.

"Experiments

Experiments on freezing and thawing in a perfect vacuum might give light to this ſubject: as I ſuſpect, from the great expanſion of ice, that air muſt be generated in the act of freezing, and given out in thawing. A bit of ice might eaſily be diſſolved in the Toricellian vacuum, to aſcertain whether it parted with air in thawing."

Soon after I received this letter, I endeavoured to ſubject this opinion to an experimental proof, in the following manner:

As much water was put into the upper end of a wide barometer tube, as filled it to two inches: it was then frozen in a freezing mixture, the tube was filled with mercury, and inverted into a veſſel of the ſame.—The mercury did not remain ſuſpended ſo high as the ice, but there was a vacuum of about a quarter of an inch between them. The place where the mercury ſtood was accurately marked, and the ice was ſuffered to thaw, which in about half an hour was completely done. The water was ſupported upon the mercury to the height of about two inches, and the mercury was found depreſſed very nearly $\frac{1}{7}$ of an inch, which was undoubtedly owing to the preſſure of the two inches of water. When the tube was inclined, the water and mercury entirely filled it; a proof that no air had been extricated during the thawing of the ice.

 I next

I next made the experiment on a large ſcale, in the following manner;—a tall glaſs jar which held near half a gallon, was filled with broken pieces of ice, water was poured into it to expell the air from the interſtices, the jar was then carefully inverted in a veſſel of water, and the ice ſuffered to thaw, but no air was extricated excepting a ſmall bubble not the ſize of a pea, which was probably confined between the particles of the ice, as we generally ſee it. As the ice melted, I introduced more in pieces, by juſt raiſing up the edge of the jar, but not above the water. The pieces of ice being ſpecifically lighter than the water, aroſe to the upper part of the jar. In this manner I introduced on the whole not leſs than ten pounds of ice, yet no air was extricated.

From the reſult of theſe experiments, may we not conclude, that we are yet ignorant of the nature of the "*Great Bear or Dragon*" of the north, which at times ſuddenly drinks up, and as ſuddenly at other times vomits out one fifteenth part of the atmoſphere?"

APPENDIX.

APPENDIX.

(A.)

COPY OF A LETTER FROM Mr. COPLAND, OF DUMFRIES.

Dear Sir,

I MOST readily ſeize this opportunity to correct the laſt obſervations in my letter of January 15th. 1793, (ſee page 271). The ſtate of the phenomena appears from farther experience to be different from what is there expreſſed.

When two rain-gages are kept at different altitudes, and at no great diſtance from each other, the quantities of water collected by them are found alternately to exceed each other on a variety of occaſions. The loweſt of my gages ſtands only two feet above the ground; the ſuperior ſeven feet. In all heavy rains, or when the falls are of any duration, the former exceeds the latter at a medium of about a twenty-fifth part of the whole quantity in the gage; and in ſummer this exceſs appears to be greater than in winter. So great an increaſe of precipitation in a difference of only five feet of altitude in the atmoſphere, is a proof that the ſtratum or portion of air, which is in a precipitating ſtate, is probably of no great depth: For when allow-

ance is made for the greater rarity above, it ſhould not, on theſe occaſions, extend beyond two hundred feet from the ſurface. But frequently in the fineſt weather, when the precipitation ſeemed to be confined near the ſurface, as in the time of fogs and heavy dews, the inferior exceeded the ſuperior gage one half, and on ſome occaſions, received the whole of the quantity precipitated. In like manner, at the beginning of moſt falls, the precipitation ſeems to be moſt copious near the ſurface, and gradually to aſcend, or proceed from a more elevated portion of the atmoſphere; till at laſt, when the fall is nearly over, the ſtratum next the ſurface, is not only *not* in a precipitating ſtate, but then beginning to reabſorb moiſture, and to be diſpoſed to combine with it again. In ſuch caſes the inferior gage becomes *minus*, and when ſo, is no doubt a ſign that the rain is nearly over. Yet from this circumſtance no concluſion can be drawn, how long it may continue fair; as in ſome caſes the precipitation has been obſerved to commence in a few hours, and run on again as before. On very few occaſions did the precipitations appear to have proceeded at the beginning from an elevated portion of the atmoſphere, as the inferior gage was *minus*; and, at the end of theſe falls, it was as certainly obſerved to be *plus*. There is therefore

reaſon

reaſon to conclude, that when the precipitation begins from an elevated portion of the atmoſphere, it ends near the ſurface, and *vice verſa.*

It appears to me, that the only indications reſpecting the weather which can be taken from two gages placed as above, ſhould be expreſſed as follows; viz. That when the exceſs in the under gage continues to be abſent a twenty-fifth part, or ſomething leſs, of the whole quantity, the fall will not be ſoon over, as the precipitation is going on pretty generally, or through a large portion of the atmoſphere; but when the quantities in the gage are equal, or the inferior one either remarkably *plus* or *minus*, after having been for ſome time *plus*, the fall will probably ſoon be over; becauſe there is then reaſon to conclude, that the precipitation is confined to a thin ſtratum of the atmoſphere. Some inſtances of this nature having occurred after I began to keep my gages ſituated as above deſcribed, I was induced to infer that to be a general rule, which is juſt only in particular ſituations.

With regard to another obſervation, ſtated in that letter, reſpecting the barometer, I think many phenomena of the weather, obſerved ſince that time, have confirmed it. But I ſhall only notice what happened laſt winter, when the application of ſuch rules ſhould be

moſt

moſt conſpicuous, from the temporary influence of the ſun having leſs effect in varying the natural phenomena.

It is not eaſy in any other way, to account for the want of ſevere cold, and almoſt of froſt alſo, till long after the year was finiſhed, when the weather was dry, except from its being accompanied with the higheſt barometer, and that for the longeſt period of time perhaps ever remembered at the ſeaſon; and it is very remarkable we had here more than three weeks, near the middle of winter, of perfectly dry weather without any froſt, except two mornings, when it was ſo ſlight as to diſappear entirely by mid-day, owing to the influence of the ſun; all which time the wind blew from the North and Eaſterly points, which very ſeldom occurs at that time without hard froſt.

During that period, the mean of the barometer, from the 15th. of November, to the 8th. of December, was full thirty inches, being more than $4\frac{1}{2}$ tenths above the medium of the ſeaſon. The mean heat was 44,52 degrees, being five above the medium; and the falls were about one-third of what uſually takes place at that time: but theſe being not altogether the complete or adequate conſequences of ſuch an aberration of the barometer, heat or dry weather was ſtill to be expected. Accordingly a moſt

remarkable

remarkable warmth took place, in the midſt of great falls of rain, for about three weeks after.

I wiſh to obſerve farther, that on inſpecting the ſtate of the barometer, thermometer, and falls, during the year 1793 (which has been made out as accurately as my time and leiſure would permit) it will appear that every aberration of the barometer has been accompanied or followed by an evident deviation of temperature above or below the medium of the ſeaſon, taken together with a greater or leſſer extent of falls; and is, if not completely anſwered during the month, or in the commencement of the next, always ſufficiently compenſated for at ſome diſtance. It alſo appears that this rule may be depended on, viz. that when a change of weather, either to good or bad, has been indicated by undoubted ſigns, and is impending; the longer it is delayed, the more complete it will be whenever it commences. Thus we find the height of the barometer in January not being completely anſwered in that month, that in February the heat that was owing enſued, notwithſtanding the lowneſs of the barometer; which again ſeems to have been fully anſwered by the extent of falls. In March, the cold and falls being more than proportionate to the ſtate of the barometer, warm or fair weather was therefore due. This however

however was not duly paid in April, May, or June; but the account was at laft completely balanced in July. The remaining months will be found to proceed in a fimilar manner.

But, left my former explanation of thefe phenomena fhould be lefs complete or diftinct than could be wifhed, I fhall endeavour to exprefs my meaning in other words, and with as much precifion as poffible. Every aberration, then, of the barometer above or below the medium of the feafon, when not completely balanced by an equal deviation in the oppofite direction, is either accompanied, or (what is moft frequently the cafe) is followed by one of the three following confequences: Every tenth of an inch of rife or fall in the barometer is anfwered, in the firft place, by nearly two degrees of heat being added to, or fubtracted from, the mean heat of the time. 2d. It is anfwered by nearly one half lefs, or one half more of falls, than what is the ufual quantity which is precipitated in that feafon. And 3d. It is anfwered by both thefe confequences together. This is what moft frequently occurs; but the proportions nearly as here ftated are always taken in the account.

I by no means pretend to fay, that thefe confequences are abfolutely to be expected; becaufe feveral circumftances often feem to occur

occur which prevent them from being immediate or complete ; fuch as, firft, the uncertainty whether thefe alterations of the barometer are accompanied, are to be foon followed, or are only at a confiderable diftance of time to be anfwered by thefe phenomena. 2d. When the temperament or difpofition of the feafon has a tendency to be dry or wet, the weather will refift feveral opportunities or indications of change,* before it will alter its prefent ftate. And 3d. a confiderable fall, or a great degree of heat or cold coming on fuddenly, will completely anfwer a greater aberration of the barometer, and for a longer time than what would otherwife have been the cafe. The greater falls in the beginning of laft year, and the leffer towards the end of it than what were indicated by the barometer, may be fufficiently accounted for from the fecond of thefe pofitions.

It was fuggefted to me by fome intelligent perfons, that a Calendar of Flora, properly conducted, might be of ufe to afcertain in what parts of the Ifland the feafons are more or lefs early or late ; and whether a tendency to degenerate and grow colder can be obferved in the climate of this country : a fuppofed confequence of what has been by fome perfons

* See page 243.

alledged of an increafe of ice to the northward.* I have therefore endeavoured to collate one which was only begun in May laft, with one kept by the Rev. Dr. Burgefs, of Kirkmichael, about eight miles north-eaft of this town, from the year 1773 to 1776. I have confined myfelf to thofe fubjects that are generally to be met with in every part of the kingdom. From my carrying on bufinefs in a town, my opportunities for fuch an undertaking are not fo complete as could be wifhed, but in future I hope to be affifted by others, who may be, in every refpect, better fituated for fuch obfervations.

A Calendar

* This point has been much difputed. M. De Luc fupports the idea here mentioned. He expreffes himfelf as follows. "One cannot doubt concerning the increafe of all the Glaciers of the Alps; their *very exiftence* is a proof, that in preceding ages, the quantity of fnow which has fallen during the winter, has exceeded the quantity melted during the fummer. Now, not only the fame caufe ftill fubfifts, but the cold occafioned by the mafs of ice already formed, ought to augment it ftill farther, and thence more fnow ought to fall, and a lefs quantity of it muft be melted." Though this fact be admitted, it is contended by a learned member of this Society, that it by no means follows that there is an annually increafing quantity; for befides the heat of the air in fummer, there is another caufe which tends to prevent any *indefinite* augmentation of congealed

CALENDAR of FLORA, for M.DCC.XCIII. kept at Dumfries.

May 3d. and for the three following days, the common Swallow *(Hirundo ruſtica)* came.

—— 8th. The large Martin or Swift (*Hirundo Apus)* came, and the ſame day the Cuckoo, *(Cuculus canorus)* was firſt heard.

gealed water: the *internal heat of the earth.*† The general heat of the ſprings of water ſituated deep in the bowels of the earth, is about forty-eight degrees. In mountainous countries it may be ſomewhat leſs, but ſufficient notwithſtanding for the purpoſe here mentioned. When the ſnow incumbent on any ſpot of ground, is but thin, it may ſo far cool the earth, that the internal heat may not be able to diſſolve it; but when the bed is thick enough to protect the earth from the influence of the atmoſpherical cold, that ſurface of the earth may, even in the coldeſt winters, receive more heat from the earth than cold from the atmoſphere, and be therefore diſſolved at all ſeaſons of the year.

Now we know that facts are in favour of this reaſoning; for ſtreams of water, and even rivers iſſue from the bottom of the Glaciers in the Alps, in the greateſt ſeverity of winter: ſo that whether this be allowed to depend upon the internal heat of the earth or not, a conſtant thaw of the ice or ſnow which is contiguous to the ſurface of the earth, cannot be denied; and this added to other cauſes, may render it probable that the quantity of congealed water has its limit even in the coldeſt country.

† Watſon's Chemiſtry, vol. III. p. 184.

June 25th. A few of the early ſtrawberries and cherries on the walls ripe; and, in favourable ſituations, the loweſt flowers of the Fox Glove *(Digitalis purpurea)* in full blow.

—— 27th. The ſown graſs begun to be cut for hay.

—— 30th. Wheat beginning to ſhoot.

July 9th. Some flowers of the Elder *(Sambucus Ebulus)* in full blow, and moſt near opening.—A few of the middle flowers of the Mugwort *(Artemiſia vulgaris)*, and alſo ſome on the Horſe Thiſtle beginning to open.

—— 12th. Common Thiſtle ditto.—The oats and barley ſhooting faſt, and the cutting of hay in the midſt, which was on the whole a thin crop.

—— 20th. The ſmall ſea Trout (a ſpecies of ſalmon) called here the *Hirling*, beginning to run hard in the river.

Auguſt 1ſt. The wheat and barley beginning to alter in colour in a few places.

—— 4th. The Swift *(Hirundo Apus)* gone, and oats beginning to colour.

—— 12th. One field of barley and another of oats, cut near the town.

—— 28th. Harveſt became general in the vale of Nithsdale.

Sept. 14th. The Bramble Berry *(Rubus fruticoſus)* beginning to be ripe.

—— 21.

—— 21. Some of the berries on the Elder *(Sambucus Ebulus)* beginning to colour. The crops all cut down except late fields and patches. The Houfe Swallow *(Hirundo ruftica)* beginning to depart.

—— 23d. The fwallows gone.

—— 30th. The crops all got in except late fields, &c.

Oct, 1. The leaves beginning to fall from fome of the afh-trees and limes. The berries the elder and bramble in the midft of ripening, but have little flavour. Some grain on a very late foil only cutting, at five miles diftance from this place.

Nov. 1ft. That late crop now got in, and thus concluding one of the fineft harvefts ever known in this country, the late grain being equally well ripened and got into the barns with the moft early, and over the whole country a heavy crop.—The firft fnow was vifible on the tops of the mountains yefterday; and the firft froft, of any confequence, was noticed this morning.

—— 10th. Moft of the potatoe ground now fown with wheat, there being little more wheat except on fields where potatoes were growing fown in the country.—Many wild geefe *(Anas Anfer)*, field-fares *(Turdus pilaris)*, wood-

cocks

cocks *(Scolopax ruſticola)* and other northern birds came about this time.

Dec. 8th. Moſt of the wheat ſo far ſprung as to be out of the power of the froſt to hurt it.

—— 20th. The graſs on good paſtures looking very green in conſequence of the mild weather, and many of the furze buſhes *(Ulex europeus)* beginning to bloſſom.

—— 25th. Some ſmall furze buſhes covered with bloſſoms, and the wall-flowers *(Cheiranthus Cheiri)*, blowing freely.

Calendar of Flora, by the Rev. Dr. BURGESS, *of Kirkmichael.*

Feb. 8, 1776. The Sky Lark (*Alauda arvenſis*) began to ſing.

—— 10th. The Lapwing (*Tringa Vanellus*) appeared.

March 15th. Oats begin to be ſown on good ſoils.

—— 17th. The Curlew (*Scolopax Arquata*) appeared.

—— 31ſt. The Sand Martin (*Hirundo riparia*) came.

April 24th. The Cuckoo (*Cuculus canorus*) ſung, which it was obſerved to do for the firſt time on the 27th, of the ſame month, 1775.

Feb.

Feb. 27th. Barley ſown.—It was begun to be ſown on the ſame day 1774.

—— —— The Houſe Swallow (*Hirundo ruſtica*) appeared.

—— 29th. 1775. The little black Martin (*Hirundo urbica*) came.

May 2d. 1775. The Houſe Swallow appeared.

—— 8th. 1774 and 1776 the ſame, and the little Martin alſo appeared.—On the 4th. 1773, the tops of the hills were covered with ſnow, and during the firſt fortnight of the month there was generally a froſt in the morning, which did much damage to the fruit, potatoes, &c.—On the 15th. 1776, the little Martin appeared.—17th. 1775, the great black Martin (*Hirundo Apus*) appeared.—20th. 1775, the Goat-ſucker (*Caprimulgus europeus*) appeared.—27th. 1776, the large Martin or Swift came.—July 22d. 1774, the grain not fully ſhot.—29th. 1776, barley cut that had been ſown April 27th.—31ſt. 1775, barley cut in an early part of the country.—Auguſt 6th. 1775, oats colouring faſt, and on the 17th. wheat cut.—10th. ditto the Goat-ſucker diſappeared.—14th. of ſame year the great Martin or Swift diſappeared.—22d. 1775, harveſt became general.—18th, of ditto, oats cut, which were ſown March 14th. interval one hundred and fifty-ſeven days.—September 5th. 1776, wheat cut, which

was

was fown March 27th. interval one hundred and fixty-two days.—6th. 1773, oats cut.—7th. 1774, oats cut down the 15th. of March, being the hundred and feventy-fixth day from the time of fowing, which gives a medium for the commencement of cutting oats in this country to be about the 31ft. of Auguft, or the 1ft. of Sept. and for the time of oats being in the ground, before it is fit for reaping, one hundred and fixty-five days.—Auguft 30th. 1776, barley cut that was fown April 27th.—September 1ft. 1774, barley cut that was fown May 1ft. which gives a medium for the commencement of the cutting of barley to be in this country about the 22d. of Auguft, and for the time of its being in the ground before it is fit for reaping, one hundred and thirteen days.

September 5th. 1774. A fharp froft which hurt the late grains, and damaged the potatoes. 18th. of ditto, the houfe fwallow departed. —25th. the little martin difappeared.—6th. 1775, houfe fwallows gone.—23d. fome of the little martins gone.—30th. 1775, harveft moftly finifhed, but in 1773 and 1774, harveft not nearly concluded before the end of October. He ftates, that the harveft 1772 was particularly wet; the falls in the three laft months of that year being 21,3 inches in depth, and that the grain was fo lodged, grown, and rotted, that a great

a great part of it was loſt; and that ſome farmers of a dilatory diſpoſition had not got in all their grain on the 23d. of December. He alſo obſerves, that the martins and houſe ſwallows appear about ten days ſooner on the coaſt of Solway Firth, and about Dumfries, than where he reſides.

On the 29th. of December 1775, he takes notice of an earthquake being felt upon his ſite, through all Annandale and Crawford Moor, which continued about fifteen ſeconds.

I have the honour to be, dear Sir,

Your moſt obedient, &c.

ALEX. COPLAND.

Dumfries,
Feb. 2d. 1794.

(B.)

Meteorological Obſervations, by DR. CAMPBELL, *of Lancaſter.*

I. When the wind is in the S. W. quarter in the ſummer and autumnal ſeaſons, and the temperature of the air is unuſually cold for the ſeaſon of the year, both to the feeling and the thermometer, with a low barometer, it is a ſign that much rain may be expected. Theſe appearances are accounted for by the author of the *Botanic Garden* with his uſual ingenuity, upon the principle of the ſudden expanſion of the air coming from the ſouth, occaſioning cold, and a precipitation of its moiſture.

 II. All

II. All heavy rains, viz. ſuch as ſwell the rivers conſiderably ſo as to occaſion floods, come on with the wind at S. and from that to the S. W.; and moſtly terminate with the wind increaſing in force, and veering round to the weſt. When the wind is in the other points, the weather is generally dry, or if it rains, the rain is neither heavy nor laſting.

An additional reaſon why theſe winds are ſo productive of rain, in this ſituation, ſeems to be, that when they bring the clouds loaded with moiſture from the ſouth and ſouth-weſt quarters, theſe are driven with violence againſt, or forcibly attracted by the high range of hills, which divide Yorkſhire from Weſtmorland and Lancaſhire. In conſequence of this their contents are more completely depoſited on this ſide of theſe mountains, than would have been the caſe had the country been more level. I have been informed, that the depoſition is frequently ſo complete on the weſtern ſide of theſe hills, that whilſt we are deluged with rain, the clouds which paſs over to the Yorkſhire ſide appear fleecy and light, and that the weather is dry. A caſe which I believe is not uncommon, where a high ridge of hills runs through a country.* This

* Dr. Campbell's obſervation is very juſt. The ſummer of 1792 was remarkably dry in Yorkſhire, and all the eaſtern ſide of the Engliſh Appenine, was burnt up for want of rain; while on the weſtern-ſide they had plenty of rain, and moſt abundant crops of graſs. T. G.

This influence of the hills in attracting the clouds, and occafioning a fuperabundance of rain, is no where more confpicuous than at Kendal, where (though only twenty-one miles diftant) the quantity that falls is one-third more than at Lancafter; and it is by no means unufual to fee, from the church-yard at Lancafter, the hills about Kendal involved in thick clouds, whilft the fky on this fide Farlton-Knott (a high rock about two miles north of Burton) appears perfectly clear.

A very ftrong inftance of this influence came under my obfervation a few years ago. I was at *Peel Caftle*, which is fituated on an Ifland at the wefternmoft point of that low tract of country, which ftretches about ten miles from the foot of the Lancafhire mountains, near Ulverftone, to the weftward, where it meets the fea. The wind was ftrong from the S. W. the day cloudy, with fun-fhine at intervals; but not a drop of rain. On going the next day to Ulverftone, we found the roads perfectly dry till we came within three or four miles of the town, when we faw marks of heavy rain, and found upon inquiry, that it had rained there the whole afternoon. Here the clouds which paffed readily over the low tract of country, on approaching the high hills, were attracted by them, producing an additional quantity of rain in their vicinity.

 III. Taking

Remarks on the Barometer.

III. Taking the generally adopted ideas to be juſt, viz. that when the quickſilver is high (or towards thirty inches) with the wind to the north of the weſt and S. E. points, it is an indication of fair weather (provided it has not riſen too ſuddenly); and that when the quickſilver is low (or towards twenty-eight inches,) with the wind in the S. or S. W. points, it is an indication of rain; my expectations of the *more immediate future ſtate of the weather*, in any ſituation of the quickſilver, are taken from the appearance which the ſurface of the quickſilver in the tube exhibits. If this be convex (i. e. with a roundiſh, ſomewhat globular appearance) it is a certain indication that the quickſilver is either riſing, or that it keeps a propenſity to be ſtationary, in oppoſition to a falling ſtate. On the contrary, when the ſurface of the quickſilver exhibits a concave, ragged, or flat appearance, it ſhows that it is dropping, or that it has no tendency to riſe. The reaſon of theſe appearances ſeems to be, that when the quickſilver is riſing in the tube, the particles neareſt the ſides are attracted by the glaſs, and retarded in their progreſs upwards, whilſt that part of the quickſilver which is towards the center of the tube, being out of the influence of this attraction, riſes with more freedom,

freedom, and conſequently higher, and thus gives the bulbous or convex appearance. On the contrary, when the quickſilver is falling, the ſame attraction ſubſiſting betwixt the particles of quickſilver in approximation to the ſides of the tube and the glaſs, theſe will be retarded in their deſcent; whilſt the quickſilver towards the center will ſink more freely, and the concave, irregular, or flat appearance will obtain as the tendency to ſink is more or leſs prevalent; for the more it is diſpoſed to fall, the more concave will the ſurface be. But to make this appearance of the quickſilver properly conſpicuous, the tube of the barometer ſhould be of a certain ſize, *e. g.* about half an inch in diameter: becauſe when the diameter of the tube is very ſmall, the quantity of the quickſilver that will be attracted by the ſides of the tube, will bear ſo large a proportion to the whole, as always to exhibit a convex appearance; whilſt if the tube be very large, the proportion of the quickſilver that will be within the attraction of the ſides of the tube, will be ſo ſmall, that the convexity will be ſcarcely diſcernible, and it will always exhibit a flat or concave ſurface, as I have ſeen to be the caſe with a barometer of nearly an inch diameter.

(c)

Obſervations on the Temperature of the Sea at Liverpool, by the late MATTHEW DOBSON, M. D. *Communicated by Dr.* PERCIVAL.

The ingenious Count Marſigli in his philoſophical Eſſay towards a hiſtory of the ſea, from which the Royal Academy of Sciences at Paris have made a number of extracts, obſerved, that the heat of the ſea at different depths, provided the depths be very conſiderable, is nearly equable; that the degree of heat is about temperate, or fifty-one degrees of Fahrenheit's Thermometer; and that the variations which are diſcovered towards the ſurface, are either the effects of climate, or ariſe from the particular circumſtances of expoſure on different coaſts.

It may be of uſe therefore to aſcertain the different temperatures of the ſea at different ſeaſons, and on different ſhores; that phyſicians may with certainty direct their patients to ſuch places; and at ſuch ſeaſons as are beſt adapted to their reſpective conſtitutions and complaints.

The variations in the temperature of the ſea at Liverpool, are conſiderably greater than on any other coaſt, and ariſe from very obvious cauſes. The ſea, before it enters the river Merſey, is diffuſed over a wide extent of flats and ſand-banks, which are in many parts left dry, during certain times of the tide. The heat

heat of the fummer, therefore, and the cold of the winter have a very powerful effect to alter the natural temperature of the fea.

To afcertain thefe variations an experiment was made, about the middle of each month, at high water, and during the time of fpring tides. The experiment was made with Fahrenheit's Thermometer, and where the river enters the new dry dock.

The firft column of the following table contains the temperature of the fea; the fecond the temperature of the open air in the fhade at eight o'clock in the morning of the fame day during the year 1772; and the third column the temperature of the external air at two in the afternoon.

1772	Temperature of the fea.	Air at 8 A.M.	Air at 2 P. M.
January	36	34	38
February	36	33	39
March	38	38	43
April	47	48	49
May	55	53	58
June	64	62	65
July	68	65	69
Auguft	65	63	67
September	60	57	61
October	55	53	58
November	44	40	47
December	48	38	43

From

From this table it appears, that the temperature of the fea at Liverpool, varies during the courfe of the year 32°. viz. from 36 to 68, or from 15 degrees below to 17 degrees above temperate.

It appears likewife, that the fea when warmeft is 14 degrees colder than Buxton Bath,* and 30 degrees below the heat of the human body.

During the months of June, July, and Auguft, the fea is nearly of the fame temperature with Matlock Bath, and in the fucceeding months becomes ftill colder, fo at laft to form an extremely cold bath, only four degrees above the freezing point. The fame latitude in the temperature of the fea will not occur in other coafts, where the fhore is cold, the fea deep, and confequently not expofed in fo fhallow a body to the action of the fun and air.

* The heat of Buxton Bath is 82°. that of Matlock 68, according to Dr. Percival's experiments.

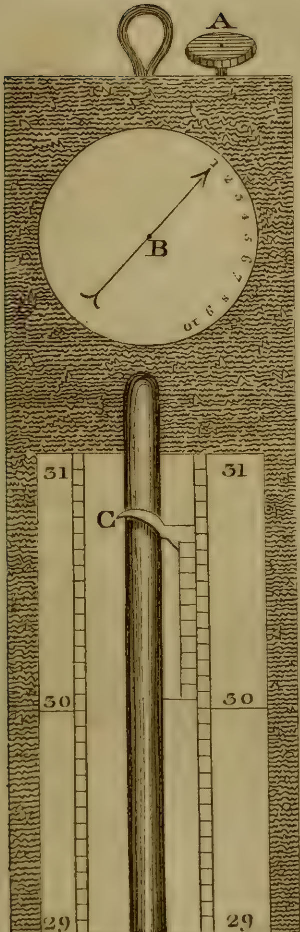


Fig. 1

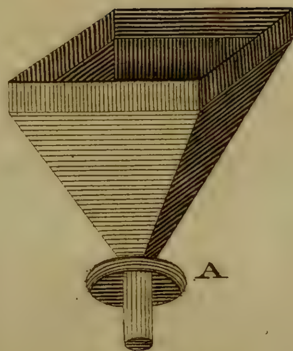


Fig. 2

LIST OF BOOKS

PRESENTED TO

THE SOCIETY.

American Academy of Arts and Sciences.	Memoirs of the American Academy of Arts and Sciences. Vol. I. Boſton: 1785. 4°.
James Anderſon, L. L. D. F. R. and A. SS. Edin.	Miſcellaneous Obſervations on planting and training timber trees. Edinburgh: 1777. 8°.
————————	Eſſays relating to Agriculture and Rural affairs. Third edition. 2 vols. Edinburgh: 1784. 8°.
————————	Account of the preſent ſtate of the Hebrides and Weſtern coaſts of Scotland. Edinburgh: 1785. 8°.
Society of Antiquaries of London.	Archæologia. Vol. XI. Lond. 1794. 4°.
Sir George Baker, Bart. F. R. S.	Medical Tranſactions, publiſhed by the College of Phyſicians in London. 3 Vols. Lond. 1768. 8°.

Sir Richard Clayton, Bart. Connubia Florum. Auctore D. de la Croix: Notas & observationes adjecit R. Clayton. Bathoniæ: 1791. 8°.

——— A Critical Inquiry into the Life of Alexander the Great by the ancient Historians: from the French of the Baron de Saint Croix. Lond. 1793. 4°.

Mr. John Dalton. Meteorological Observations and Essays. London: 1793. 8°.

Edward Hussey Delaval, Esq. F. R. S. An experimental Enquiry into the cause of the changes of colours in opake and coloured bodies. London: 1787. 4°.

——— Ricerche sperimentali sulle cagioni del cangiamento di colore ne' corpi opachi e colorati trasportate in Italiano da Gio. Francesco Fromond. Milano: 1779. 8°.

John Talbot Dillon, Knt. B. H. R. E. Travels through Spain. London: 1782. 4°.

——— History of Peter the Cruel. 2 vols. Lond. 1788. 8°.

——— Historical and critical Memoirs of the General Revolution in France, in the year 1789. London: 1790. 4°.

Rev. James Douglas, F. A. S. A dissertation on the Antiquity of the Earth. Lond. 1785. 4°.

Capt.

Capt. John Drinkwater.	History of the late siege of Gibraltar. I & II Edit. Lond. 1786. 4°.
Royal Society of Edinburgh.	Transactions of the Royal Society of Edinburgh. Vol: II. Edin. 1790. 4°.
A. Fothergill, M.D. F.R.S.	A new experimental inquiry into the nature and qualities of the Cheltenham Water. Bath. 1785. 8°.
Thomas Fowler, M. D.	Medical Reports on the effects of Arsenic in the cure of Agues, Remitting Fevers and periodic Head-achs. London: 1786. 8°.
M. B. S. Froſſard.	Sermons de M. Hugh Blair, traduits de l' Anglois. II Tom. Lyon: 1784. 8°.
Thomas Garnett, M.D.	Experiments and Observations on the Horley-Green Spaw, near Halifax. Bradford: 1790. 8°.
William Hawes, M. D.	Transactions of the Royal Humane Society. Vol. I. Lond. 1790. 8°.
John Haygarth, M. B. F. R. S.	An Enquiry how to prevent the Small-pox. Chester: 1784. 8°.
———————	A Sketch of a Plan to exterminate the casual Small-pox from Great Britain. 2 Vols. Lond. 1793. 8°.
Mr. Thomas Henry, F. R. S.	An account of a method of preserving water at sea from putrefaction. Warrington: 1781. 8°.

Mr. Thomas Henry, F. R. S.	Effays on the effects produced by various proceffes on atmofpheric air. From the French of M. Lavoifier. Warrington: 1783. 8°.
Edward Holme, M. D.	Differtatio medica inauguralis de Catarrho. Auctore S. A. Deiman. Lugd. Bat. 1793. 4°.
————————	Differtatio phyfiologica inauguralis de ftructura et ufu Vaforum Abforbentium. Auctore Edv. Holme. Lugd. Bat. 1793. 4°.
————————	Neue Chemifche Nomenclatur für die deutfche fprache von Chriftoph Girtanner. Berlin: 1791. 8°.
Mr. John Holt.	Characters of the Kings of England. Lond. 1794. 12°.
————————	General View of the Agriculture of the County of Lancafter. Lond. 1794. 4°.
Thomas Houlfton, M. D.	A new Method of curing the Small-pox, with a fpecimen of mifcellaneous obfervations on medical fubjects: tranflated from the Latin of John Frederic Clofs, A. M. Phil. & Med. Doct. Lond. 1774. 8°.
————————	Effay on the Liverpool Spaw-water. Liverpool: 1773. 8°.

Thomas

Thomas Houlſton, M. D. Obſervations on Poiſons; and on the uſe of Mercury in the cure of obſtinate Dyſenteries. Lond. 1784. 8°.

A Hunter, M. D. F. R. S. Silva: or a Diſcourſe of Foreſt Trees, &c. by John Evelyn, Eſq. to which is added Terra, a philoſophical Diſcourſe of Earth. 2 Vols. York: 1784. 4°.

Royal Iriſh Academy. Tranſactions of the Royal Iriſh Academy, 1788. Dublin. 4°.

James Johnſtone, M. D. Tentamen medicum inaugurale, de aëris factitii imperio in primis corporis humani viis. Auctore Jac. Johnſtone. Edinburgi: 1750. 8°.

——— An Eſſay on the uſe of the Ganglions of the Nerves. Shrewſbury: 1771. 8°.

——— A Treatiſe on the Malignant Angina. Worceſter: 1779. 8°.

John Coakley Lettſom, M. D. F. R. and A. SS. Hiſtory of the Origin of Medicine. Lond. 1779. 4°.

——— The works of John Fothergill, M. D. Lond. 1784. 4°.

John Hyacinth de Magelldn, Eſq. F. R. S. Deſcription de quelques machines & remedes qu' on pourroit eſſayer pour détruire à peu de frais les fourmis nuiſibles de la Martinique en Amerique, ainſi que d'autres inſectes, par M. le Baron de Hupſch. Cologne: 1780. 12°.

John

John Hyacinth de Magellan, Esq. F. R. S.	Dei fenomeni che il sangue ed i vasi sanguigni presentano nel vuoto pneumatico. Milano: 1783. 8°.
———	Description of a Glass Apparatus for making mineral waters, &c. Lond. 1783. 8°.
———	An Essay towards a System of Mineralogy, by Axel Frederic Cronstedt. Second edition. 2 Vols. Lond. 1788. 8°.
Francis Maseres, Esq. F. R. S.	Scriptores Logarithmici. 2 Vols. Lond. 1791. 4°.
E. Peart, M. D.	The generation of Animal Heat investigated. Gainsborough: 1788. 8°.
———	On the Elementary Principles of Nature. 1789. 8°.
———	On Electric Atmospheres. 1793. 8°.
Mr. F. Penrose.	Letters Philosophical and Astronomical. Plymouth: 1789. 8°.
Mr. Thomas Pole.	The Anatomical Instructor. Lond. 1790. 8°.
Joseph Priestley, L. L. D. F. R. S. &c.	Experiments and Observations on different kinds of Air, and other branches of Natural Philosophy. 3 Vols. Birmingham: 1790. 8°.
Rev. John Radcliffe, A. M.	Bibliotheca Chethamensis. II Tom. Mancunii: 1791. 8°.
Samuel Foart Simmons, M. D. F. R. S.	An Account of the Life and Writings of the late Wm. Hunter, M. D. F. R. S. and S. A. Lond. 1783. 8°.

Joseph

Joseph C. Walker, Esq. M. R. I. A. Historical Memoirs of the Irish Bards. Dublin: 1786. 4°.

Martin Wall, M. D. Medical Tracts by the late John Wall, M. D. of Worcester. Oxford: 1780. 8°.

——— Dissertations on select subjects in Chemistry and Medicine. Oxford: 1783. 8°.

——— Dissertations, Letters, &c. Oxford: 1786. 8°.

Charles White, Esq. F. R. S. Observations on Gangrenes and Mortifications. Warrington: 1790. 8°.

Thomas White, M. D. Dissertatio medica inauguralis de Cynanche Tracheali. Auctore T. White. 1786. 8°.

Mr. W. Wilson. The Post-Chaise Companion: or Traveller's Directory through Ireland. Dublin: 1786. 8°.

Joseph Wimpey, Esq. Rural Improvements: or essays on the most rational methods of improving estates; accommodated to the soil, climate, and circumstances of England. Lond. 1775. 8°.

——— A Treatise concerning the principles of Human Knowledge; by Bp. Berkley, with remarks on each section, &c. Lond. 1776. 8°.

——— Letters occasioned by three dialogues concerning Liberty. Lond. 1777. 8°.

INDEX.

A.

B.

Flints

Paper

P.

R.

S.

T.

V.

W.

Y.

ERRATA.

Page 3, line 26, for "temperance" read "temperature." p. 301, l. 25, for "materie" read "materiei." p. 331, l. 7, for "as hitherto to" read "as to render it very improbable, that it ſhould hitherto." p. 371, two laſt lines, for $\frac{A^{n+1}}{\overline{n-1} + r^{n-1}}$, read $\frac{A^{n+1}}{\overline{n-1} \times r^{n-1}}$. P. 374, l. 2, from the bottom, for $-\frac{m}{m-1} \times P^2 y^{n-2}$, read $-\frac{m}{m-1} \times P^2 y^{n-3}$. p. 375. l. 1. for $r\sqrt{\frac{m}{m-1}}$, read $r\sqrt{\frac{m}{1-m}}$. P. 377, line 10, for $\sqrt{\overline{s^2+r^2} \times r}$ read $\sqrt{\overline{s^2+2} \times r}$. p. 381, l. 3, from the bottom, for $\sqrt{m P^2 - {}^2}$, read $\sqrt{mP^2-r^2}$. p. 383, l. 7, for $z \pm \sqrt{\frac{m}{m-1}}$ read $z = \pm \sqrt{\frac{m}{m-1}}$ and l. 8, for $x=$, r. $z=$. P. 384, l. 3, from bottom, for $\sqrt{y^2 + \frac{r^2-m^2}{m-1}}$ read $\sqrt{y^2 + \frac{r^2-mP^2}{m-1}}$ P. 385, l. 6, for $\sqrt{m.\overline{r^2-P^2}} \times \sqrt{r^2-mP^2}$, read $\sqrt{m.\overline{r^2-P^2}} + \sqrt{r^2-mP^2}$. P. 391, l. 13, for $n=1$, read $n=-1$. P. 392, l. 3, from the bottom, for $r^{\frac{n-3}{2}}$ is infinitely greater than p, read $r^{\frac{n-3}{2}}$ is infinitely greater than $y^{\frac{n-3}{2}}$; therefore y is infinitely greater than p. P. 393, l. 4, for $\frac{\dot{p}}{y}$, read $\frac{\dot{p}}{p}$. P. 394, l. 14, for $p\,C\,p$, read $n\,C\,\dot{p}$. P. 396, l. 2, for $\frac{m}{m-1} \times P^2 y^{n-1}$, read $\dfrac{\frac{m}{m-1} \times P^2 y^{n-1}}{y^{n-1} \times \frac{r^{n-1}}{m-1}}$

$$\frac{\frac{m}{m-1} \times P^2 y^{n-1}}{y^{n-1} + \frac{r^{n-1}}{m-1}}:$$ P. 397, l. 16, for $v \; z \; u$, read $V \, Z \, U$. P. 401, l. 10, from the bottom, for, $v =$, read $\dot{v} =$. P. 402, l. 2, from the bottom, for $A \; r$, read $A - r$. P. 404, l. 8, for $1 =$ time, read $t =$ time.

P. 405, l. 10, for $\pm \dfrac{\sqrt{\frac{m}{m-1}} \times y \dot{y}}{v \sqrt{y^2 \times \frac{r}{m-1} y - \frac{m}{m-1} P^2}}$,

read $\pm \dfrac{\sqrt{\frac{m}{m-1}} \times y \dot{y}}{v \sqrt{y^2 + \frac{r}{m-1} y - \frac{r}{m-1} P^2}}$, and 2 l. from

the bottom, for $\pm \dfrac{\sqrt{\frac{m}{m-1}} \times y \dot{y}}{v \sqrt{- \frac{m}{1-m} P^2 \times \frac{r}{1-m} y - y^2}}$,

read $\pm \dfrac{\sqrt{\frac{m}{1-m}} \times y \dot{y}}{v \sqrt{- \frac{m}{1-m} P^2 + \frac{r}{1-m} y - y^2}}$.

P. 408, l. 4, from bottom, for $\overline{q-1} \cdot r^{n-1}$, read $\overline{q-1} \cdot r^{q-1}$;

P. 409. l. 4, for $\dfrac{B^{q+1}}{r^q} = \dfrac{A^{n+1}}{r^n}$ read $\dfrac{B^{q+1}}{r^q} = \dfrac{c \, A^{n+1}}{r^n}$.

P. 410, l. 4 from the bottom. for $r \, y$, read $r \, y^2$. P. 412, l. 11, from bottom, for $n =$, read $r =$. P. 415, l. 11, for "to" read "or." P. 416, l. 6, for $r \times \dfrac{b \, V}{c^2 - V^2}$ read $r \times \dfrac{b \, V}{V^2 - c^2}$. P. 418, l. 6 from the bottom, for "the centre of force, or ſuch parts;" read, "the centre of force, being deſcribed by a centrifugal force, or ſuch parts." P. 419, l. 12, from bottom, for $- m \; A \, x^{n-1}$, read $- m \, A \, x^{m-1}$. P. 420, l. 3, from bottom, for m^n, read m^m. P. 420, l. 15, for "poſitive," read "poſſible." P. 429, l. 9. for "acdute," read "acute." P. 499, l. 2, for "another," read "an earthen." P. 640, l. 14, for "ſo at," read "ſo as at."

LIST OF PLATES.